

Manual of Good Agricultural Practices for Quality Wine Production



राष्ट्रीय अंगूर अनुसंधान केन्द्र
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Preface



At present both table and wine grapes are grown over an area of 111000 hectares in India with annual production of more than 1.23 million tones. Table grapes are the prominent in case of both area and production while wine grapes are grown over an area of 5000 hectares with annual production of 50,000 tones for the production 25.0 million liters wine. Maharashtra contributes more both in area and production followed by Karnataka, Tamil Nadu, and Andhra Pradesh. Contribution from Northern states (Himachal Pradesh, Punjab, Haryana, Uttar Pradesh) and North eastern states is very little.

Considering the end use of wine grapes the good viticulture practices in terms of selection of wine grape varieties and compatible rootstocks to various varieties and soil and agro-climatic conditions, training, pruning, thinning, fertigation, irrigation, crop protection and

appropriate method and stage of fruit for harvesting are very important. In this document, all these agricultural practices including selection of appropriate wine grape varieties and compatible rootstocks, the use of label claim chemicals for quality and safe end product are covered for the guidance of all stakeholders particularly, wine grape growers, wine makers and wine exporters keeping in view the food safety measures in the country and also for export market.

I hope all the stakeholders in grape Industry will take advantage of all the guidelines brought out in this document and comply to these requirements for quality wine production as required under the good viti-viniculture practices. I also take this opportunity to thank all my fellow Scientists, technicians and others in bringing out this useful document for the benefit of wine grape Industry.

Place : Pune
Date :18.02.2013

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Chapter 1

Wine grape cultivation brief history and present scenario



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Viticulture was believed to have been introduced to India by Persian traders sometime in the 4th millennium BC. Historians believe that these early plantings were used mostly for table grapes or grape juice rather than the production of an alcoholic beverage. In the 16th century, Portuguese colonists at Goa introduced port-style wine and the production of fortified wines soon spread to other regions. In the 19th century under British influence wine began becoming more and more familiar throughout India. Viticulture and winemaking was strongly encouraged as a domestic source for the British colonists and vineyards were planted extensively through the Baramati, Kashmir. In 1884, at the Calcutta International Exhibition, Indian wines were showcased and favourably received by the visitors to it. However, Indian vineyards were totally destroyed by unknown reasons in the 1890s.

The history of wine grape cultivation is closely related to rise and fall in the growth of wine Industry. It was a long road for the Indian wine industry to recover from the devastation at the end of the 19th century. Unfavourable religious and public opinion on alcohol developed and culminated in the 1950s when many of India's states prohibited alcohol. Vineyards were either uprooted or encouraged to convert to table grape and raisin production. Some areas, like Goa, continued to

produce wine but the product was normally very sweet and with high alcohol levels. After a long pause of several years the turning point of the modern Indian wine industry occurred in early 1980s with the founding of Chateau Indage in the state of Maharashtra. Chateau Indage winery established in 1985, studied wine and brought new technology from European countries. With it the wine grape cultivation also took a turn. With the assistance of French winemakers, Chateau Indage began to import *Vitis vinifera* grape varieties like Cabernet Sauvignon, Chardonnay, Pinot noir and Ugni blanc and started making still and sparkling wines. Other wineries soon followed as the emergence of India's growing middle class fueled the growth and development of the Indian wine industry. With the growth of wine industry wine grape cultivation began to increase to provide wine grapes locally. Many existing table grape growers also started cultivation of wine grapes and many new vineyards established for wine grape cultivation. Champagne Indage (CI), Grover, Sula wine companies established vineyards for wine grape cultivation for indigenous production of quality wines in the country. Some wineries also did contract for getting wine grapes with growers having small vineyards. Because of the concept of contract farming some growers with small vineyards started up wine grape cultivation as they were sure about the sale of their produce.

For wine there is a huge potential in Indian market and for export market there is increasing popularity of Indian wine. Indian wine exports are going up every year, as words are getting spread very fast creating awareness of Indian wines in International market. The wine market is growing at 25-30 per cent a year. The per capita consumption in India is only 0.07 litre/person/year. The biggest consumption up to 80% is however confined to major cities like Mumbai (39%), Delhi (23%), Bangalore (9%) and the foreign tourist dominated state of Goa (9%), where as Rest of India has only 20% consumption. Not only has the number of imported wines increased exponentially, the Indian producers, too, have introduced a number of new labels and wine styles. Area under wine grape cultivation is increasing in states like Maharashtra, Karnataka and Tamil Nadu in view of their policy measures for the promotion of wine grape cultivation for diversification and wine making.

Maharashtra state is a leading state in cultivation, production and export of grapes in the whole country. In Maharashtra, total area under grape cultivation is 92,000 hectares with annual production of 1810 thousand MTs of grapes. Nasik, Sangli, Solapur, Pune, Ahmednagar, Latur, Osmanabad and Satara are the main grape producing districts. In the state approximately 65 per cent of grapes are produced for eating purpose, and rest is utilized for production of raisin, grape juice, syrup, jam, jelly and wine. Now wine grape cultivation is getting focus so as to prevent losses, obtain more income and provide additional employment to rural people in the State. Now in Maharashtra total 3500 to 4000 acres area are under cultivation of wine grape varieties and it is increasing day by day to meet the demand of new upcoming grape wine

units. A total of 74 (36 in Nasik, 13 in Sangli, 12 in Pune, 5 in Solapur, 4 in Osmanabad, 3 in Buldana and 1 in Latur district) wine units had started production in year 2010.

At present 90 wineries are established in India and total production of wine is 25 million litres.

Vineyards in India range from the more temperate climate of the north-western state of Punjab down to the southern state of Tamil Nadu. Many of India's wine regions fall within the tropical climate belt. Vineyards are then planted at higher altitudes along slopes and hillsides to benefit from cooler air and some protection from wind. Some of India's larger wine producing areas are located in Maharashtra, Karnataka near Bangalore and Tamil Nadu near Cumbum Valley. Within the Maharashtra region, vineyards are found on the Deccan Plateau and around Baramati, Nashik, Pune, Sangli and Solapur. The altitude of India's vineyards typically range from around 660 ft (200 m) in Karnataka, 984 ft (300 m) in Maharashtra, 2,600 ft (800 m) along the slopes of the Sahyadri to 3,300 ft (1000 m) in Kashmir. Nasik was famous for its table grapes for a very long time and now Nasik valley which is 2000 ft. above sea level between 19-33° to 20-53° North altitude and 17-16° to 75-6° East longitude is identified for wine grape growing.

Nasik Region (Maharashtra State): Biggest wine producing region in India. This region includes Pune, Nasik and Ahmednagar. It is above 800 meter sea level. Several top wineries are located in this area including Chateau Indage and Sula Wines.

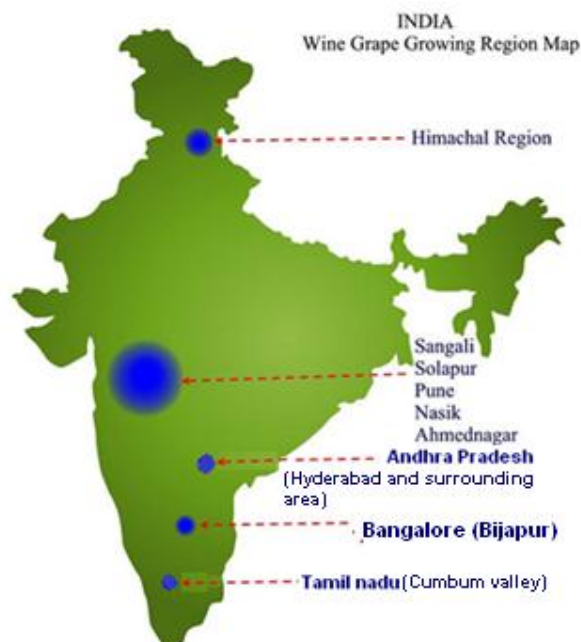
Sangali Region (Maharashtra State): This region includes Solapur, Sangali, Satara and Latur. It is above 800 meter sea level.

Bangalore Region (Karnataka State): Nandi Hills located about around 45 kilometer North of Bangalore City. Grover Vineyards is located in Nandi Hills. It is above 800 meter sea level.

Himachal Region: It is located at Northern India. It is upcoming state for

around 50000 tonnes with a productivity of 10MT/ha.

The present fact is that per person wine consumption in India is very less, The per capita consumption in India is only 0.07 litre/person/year as against 60-70 litres in France and Italy, 25 litres in US and 20 litres in



the wine production. Temperature varies from 20°C to 40°C. Unique Climate of this region attracts the wine makers to produce delicate wine grapes.

Grape statistics world vis a vis India

According to the Food and Agriculture Organization (FAO), 7,104,512 ha of the world are dedicated to grapes with a production of 67,116,255 (Tonnes) of grapes. More than 80% of world grape production is used for wine, rest is used for fresh fruit, dried fruit (raisin) and grape juice.

In India 111000 ha of area is under cultivation of grapes with a production of more than 1.23 million tonnes of grapes. Out of this 5000 ha is estimated to be under wine grape cultivation with the production of

Australia and even China has 0.4 litre. Even though wine export to other countries is highly competitive with stringent quality requirements, export is having increasing trend in last some years. Following is the statistics for export and import of wine for top ten countries in the world.

Since wine industry is the consumers of wine grapes, the wine grape cultivation totally depends on how the industry grows in India. The consumption of wine in India is minimal compared to other countries of the world. However with increased awareness, exposure to the wine culture abroad and joint efforts by industry and corporate on wine education, consumption is growing at a healthy rate every year.

In cultivation of wine grapes production is not a problem but more emphasis need to be given to produce

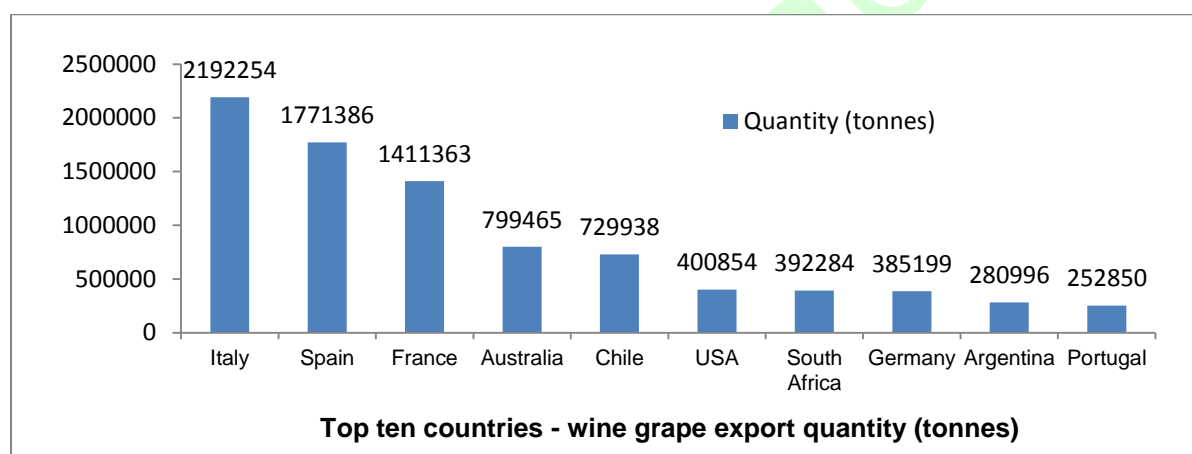
good quality grapes as wine quality is primarily determined in vineyard. Most of the wine grape growers follow cultivation practices similar to table grapes and therefore, there is a need to

intensify the research on wine grape cultivation and wine making to increase production of quality wines.

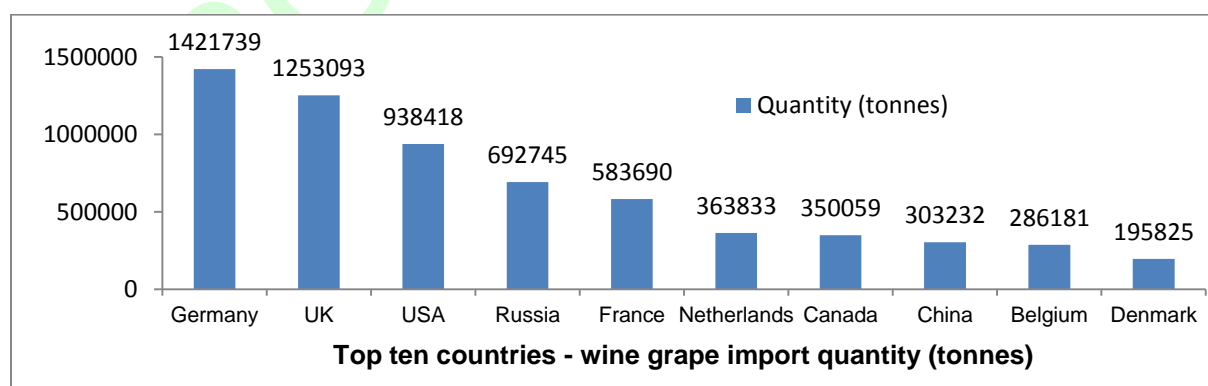
	World (2010)	India (2010)
Total area under grape production (Ha)	7,104,512	111000
Total grape production (Tonnes)	67,116,255	1230000
Area under wine grapes (Ha)	*1562378	*5000
Total wine grape production (Tonnes)	*47652541	*50000
Utilization: Table grapes	*17%	*72-76%
Utilization: Raisin	*2%	*22 -24%
Utilization: Juice	A small fraction	*0.5%
Utilization: wine	*81%	*3.5%

(*) Approximate figures

Wine Export Quantity (tonnes)



Wine Import Quantity (tonnes)



Following is the statistics for export and import of wine from India.

Years	2005	2006	2007	2008	2009	2010
India -Wine Export Quantity (tonnes)	473	1059	1262	1681	1513	694
Years	2005	2006	2007	2008	2009	2010
India -Wine Import Quantity (tonnes)	1690	1815	3187	3004	1930	2023

Chapter 2

Important wine varieties



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The potential for wines has considerably increased owing to the awareness about the health promoting characters in wines, particularly red wines, change in living styles, and the standard of living as well as the promotional activity of the Government. Wine industry is capital intensive and highly skill based. There is need for credit support and related policies from the Government. Indian wine market hold enormous potential for both domestic producers as well as importers.

Wine quality depends upon grape variety, management practices in vineyard and the prevailing climate, techniques of fermentation followed and processing and aging. For selection of grape varieties for wine production emphasis should be given on economic yield, resistant to pests and diseases, adequate sugar & acid content in berries, aroma, colour shades & its profile, stability of colour and flavour in wines.

Area under wine grapes increasing in Maharashtra, Karnataka and TN due to supporting government policies. Most of wine grape growers follow cultural operations similar to that of table grapes.

One of the fastest growing cities of India, Nasik is called 'the wine capital of India' and has the largest concentration of wineries in India. It has mild climate for the most part of the year. The summers from March to

June are about 40°C, so the grapes are grown in winter. The winters from November to February are mild and dry with warm days and cool nights. Grape Varieties cultivated in this area are: Sauvignon Blanc, Chenin Blanc, Viognier, Chardonnay, Riesling, Shiraz, Cabernet Sauvignon, Merlot, Malbec, Zinfandel and Tempranillo. The vines are planted either on their own rootstock, or grafted on Dodridge, Saltcreek, SO4 etc. Vines are planted on slopes to facilitate good drainage. Plantation is done in late December and early January. Pruning of 2-6 buds in September and another pruning in April ahead of the summer to keep the grapes dormant in the hottest period. Manual harvesting is done early morning or late night, normally below 20°C. Sorting and collection of the best bunches is followed. White grapes are pressed in whole bunch, red are de-stemmed and then pressed.

Another grape growing area of Maharashtra is Baramati. Its suitable climate and soil quality makes it an important grape growing region of India. Warm summer from March to May, day temperature could be 40°C. Cold and dry winters from November to February, the mercury could fall to 8°C. About 600 mm of rainfall between June and August. The long warm days and cool nights in the region lend good colour, maturity and flavour to the grapes. Primary grape varieties cultivated are Sauvignon Blanc, Chenin Blanc, Viognier, Shiraz,

Cabernet Sauvignon, Merlot, Zinfandel. Various rootstocks are used for plantation on the slopes of the Sahyadri Valley with drip irrigation and water soluble fertilisers. Two prunings every season; forward pruning in September-October and back pruning in April. Harvesting of selected bunches is done by hand. A low yield maintains high quality of the grapes. White grapes are harvested 110 to 120 days after pruning and red grapes 150 to 170 days after pruning. The harvesting season starts in January and finishes by the end of March.

Pune has a rich history, besides being an important information technology hub with the highest per capita income in the country. Warm days and cool nights during the growing season. Annual range is between 12° and 42°C while the average temperature is 28°C. Rainfall is about 850 mm. soil is light to medium in density, loamy and mineral rich. The soil has very good drainage. Primary wine grape varieties grown in this area are: Sauvignon Blanc, Chenin Blanc, Chardonnay, Semillion, Viogner, Ugni Blanc, Cabernet Sauvignon, Shiraz, Zinfandel, Merlot, Pinot Noir, Grenache, Temprenillo and Cinsault. The Dodridge is the popularly used rootstock for the manual plantation, others being So4, Ru140, Farcial and 3390C. Drip irrigation, water soluble fertilisers and pesticides are used. Two prunings are done every season in April (to develop the canes) and October (for the yield). Harvesting starts in January and ends by March. Harvesting is usually done late in the evening, and crushing usually takes place early in the morning.

It is believed that Karnataka is blessed to make wines, with an enviable terroir and glorious heritage. Nandi Hills near Bengaluru and

Krishna Valley near Bijapur are the main grape growing areas. Overall, a pleasant climate. Warm sunny days and cool nights with rainfall between 400-600 mm over the 5 autumn months offers the perfect platform for good grapes. Soil is gravelly, loamy with a bit of clay. Well drained and rich in minerals. The area under wine grape cultivation is about 750 hectares. Grape varieties cultivated in this area are: Sauvignon Blanc, Chenin Blanc, Viogner, Clairette, Grenache, Shiraz, Cabernet Sauvignon, Merlot, Tempranillo and Zinfandel. Organic farming is followed, and fungicides are used to control mildew. Drip irrigation is preferred. Two pruning cycles due to lack of dormancy period for the grapes are followed. Forward pruning in September-October and back pruning during April-May. For Nandi Hills, harvesting seasons runs from March to May, though it is earlier in Bijapur. The grapes are crushed within 8 hours of harvesting, and cold rooms are used to cool them down.

Popular wine grape varieties

Red wine grapes

Cabernet Sauvignon

Cabernet Sauvignon is one of the world's most widely recognized red wine grape varieties. It offers wonderful flavours consisting of



Cabernet Sauvignon

blackcurrants, blackberry, chocolate, tar and leather. The beauty of this resilient red wine grape is the many

different styles of wine it is capable of yielding. While Cabernet Sauvignon can grow in a variety of climates, its suitability as a varietal wine or as a blend component is strongly influenced by the warmth of the climate. The vine is one of the last major grape varieties to bud and ripen (typically 1–2 weeks after Merlot and Cabernet franc) and the climate of the growing season affects how early the grapes will be harvested. In some regions, climate will be more important than soil. In regions that are too cool, there is a potential for more herbaceous and green bell pepper flavours from less than ideally ripened grapes. In regions where the grape is exposed to excess warmth and over-ripening, there is a propensity for the wine to develop flavours of cooked or stewed blackcurrants.

In addition to ripeness levels, the harvest yields can also have a strong influence in the resulting quality and flavours of Cabernet Sauvignon wine. The vine itself is prone to vigorous yields, particularly when planted on the vigorous SO4 rootstock. Excessive yields can result in less concentrated and flavourful wine with flavours more on the green or herbaceous side. To reduce yields, producers can plant the vines on less vigorous rootstock and also practice green harvesting with aggressive pruning of grape clusters soon after veraison. In general, Cabernet Sauvignon has good resistance to most grape diseases, powdery mildew being the most noted exception.

In many aspects, Cabernet Sauvignon can reflect the desires and personality of the winemaker while still presenting familiar flavours that express the typical character of the variety. The most pronounced effects are from the use of oak during production. Typically the first

winemaking decision is whether or not to produce a varietal or blended wine. The "Bordeaux blend" of Cabernet Sauvignon, Merlot and Cabernet franc, with potentially some Malbec, Petit Verdot or Carménère, is the classic example of blended Cabernet Sauvignon. But Cabernet Sauvignon can be blended with a variety of grapes such as Shiraz, Tempranillo and Sangiovese.

The Cabernet Sauvignon grape itself is very small, with a thick skin, creating a high 1:12 ratio of seed (pip) to fruit (pulp). From these elements the high proportions of phenols and tannins can have a stark influence on the structure and flavour of the wine, especially if the must is subjected to long periods of maceration (skin contact) before fermentation. Following maceration, the Cabernet must can be fermented at high temperatures up to 30 °C (86 °F). The temperature of fermentation will play a role in the result, with deeper colours and more flavour components being extracted at higher temperatures while more fruit flavours are maintained at lower temperature. The tannic nature of Cabernet Sauvignon is an important winemaking consideration. As the must is exposed to prolonged periods of maceration, more tannins are extracted from the skin and will be present in the resulting wine. If winemakers choose not to shorten the period of maceration, in favour of maximizing colour and flavour concentrations, there are some methods that they can use to soften tannin levels. A common method is oak aging, which exposes the wine to gradual levels of oxidation that can mellow the harsh grape tannins as well as introduce softer "wood tannins". The choice of fining agents can also reduce tannins. These fining agents will bond with some of the tannins and

be removed from the wine during filtration.



Merlot

Merlot

Merlot is a darkly blue-coloured wine grape, that is used as both a blending grape and for varietal wines. Merlot-based wines usually have medium body with hints of berry, plum, and currant. Its softness and "fleshiness", combined with its earlier ripening, makes Merlot a popular grape for blending with the sterner, later-ripening Cabernet Sauvignon, which tends to be higher in tannin. Merlot has captured the attention of the everyday wine consumer because of its fresh, ripe fruit appeal.

Merlot grapes are identified by their loose bunches of large berries. The colour has less of a blue/black hue than Cabernet Sauvignon grapes and with a thinner skin and fewer tannins per unit volume. Also compared to Cabernet, Merlot grapes tend to have a higher sugar content and lower malic acid. It normally ripens up to two weeks earlier than Cabernet Sauvignon. Water stress is important to the vine with it thriving in well drained soil more so than at base of a slope. Pruning is a major component to the quality of the wine that is produced.

A characteristic of the Merlot grape is the propensity to quickly over ripen once it hits its initial ripeness level, sometimes in a matter of a few days. As a varietal wine, Merlot can

make soft, velvety wines with plum flavours. There are three main styles of Merlot — a soft, fruity, smooth wine with very little tannins, a fruity wine with more tannic structure and, finally, a brawny, highly tannic style made in the profile of Cabernet Sauvignon. Some of the fruit notes commonly associated with Merlot include cassis, black and red cherries, blackberry, blueberry, boysenberry, mulberry, ollaliberry and plum. Vegetable and earthy notes include black and green olives, cola nut, bell pepper, fennel, humus, leather, mushrooms and tobacco. Floral and herbal notes commonly associated with Merlot include green and black tea, eucalyptus, laurel, mint, oregano, pine, rosemary, sage, sarsaparilla and thyme. When Merlot has spent significant time in oak, the wine may show notes of caramel, chocolate, coconut, coffee bean, dill weed, mocha, molasses, smoke, vanilla and walnut.

Shiraz/Syrah

Syrah or Shiraz is a dark-skinned grape grown throughout the world and used primarily to produce powerful red wines. Whether sold as



Shiraz/Syrah

Syrah or Shiraz, these wines enjoy great popularity. Syrah is used as a varietal and is also blended. This grape is also known as Syrah. It makes a soft and rich wine often characterized by smoky and chocolaty aromas. It matures faster than cabernet and is

sometimes blended with it to speed accessibility.

Syrah grapes are widely used to make a dry red table wine (sometimes marketed with the label "Shiraz"), which can be both varietal or blended. Four main uses can be distinguished:

- Varietal Syrah or Shiraz
- Syrah blended with a small amount of Viognier
- Syrah as a roughly equal blending component for Cabernet Sauvignon
- Syrah as a minor blending component for Grenache and Mourvèdre

Smaller amounts of Syrah are also used in the production of other wine styles, such as rosé wine, fortified wine in Port wine style, and sparkling red wine. Due to their concentrated flavours and high tannin content, many premium Syrah wines are at their best after some considerable bottle aging. In exceptional cases, this may be 15 years or longer. Syrah has one of the highest recommended wine serving temperatures at 18 °C (65 °F).

Wines made from Syrah are often powerfully flavoured and full-bodied. The variety produces wines with a wide range of flavour notes, depending on the climate and soils where it is grown, as well as other viticultural practices chosen. Aroma characters can range from violets to berries (usually dark as opposed to red), chocolate, espresso and black pepper. No one aroma can be called "typical" though blackberry and pepper are often noticed. With time in the bottle these "primary" notes are moderated and then supplemented with earthy or savory "tertiary" notes such as leather and truffle. "Secondary" flavour and aroma notes are those associated with several things,

generally winemakers' practices (such as oak barrel and yeast treatment).

Zinfandel

Zinfandel vines are quite vigorous and grow best in climates that are warm but not too hot, because grapes may shrivel in hot weather. Zinfandel's thin-skinned grapes grow in large, tight bunches that are sometimes prone to bunch rot. The fruit ripen fairly early and produce juice with high sugar levels. If weather conditions permit, the grapes may be late-harvested to make dessert wine.

The grapes are known for their uneven pattern of ripening: a single bunch may contain both raisin-like, over-ripe grapes and green, unripened grapes. Some winemakers choose to vinify the bunches with these varying levels of ripeness, while others hand-harvest the bunches, even by single berries, through multiple passes through the vineyards over several weeks. This extensively laborious practice is one component in the high cost of some Zinfandels.

Red Zinfandel wines have been criticized for being too "hot" (too alcoholic), although modern winemaking techniques have helped make them more approachable. When grapes are harvested, the length of fermentation, the length of the maceration period with skin contact and the level of oak aging affect the wine's taste. The degrees Brix at which the grapes are harvested dramatically affect the wine's flavour as well. White Zinfandel is normally harvested early at 20°Bx when the grapes have yet to develop much varietal character, though some examples can develop hints of tobacco and apple skin. At 23°Bx (the degree that most red wine is considered "ripe"), strawberry flavours develop. Cherry flavours

appear at 24°Bx followed by blackberry notes at 25°Bx.

Pinot Noir

Pinot noir is a black wine grape variety of the species *Vitis vinifera*. The name may also refer to wines created predominantly from



Pinot Noir

Pinot noir grapes. The name is derived from the French words for "pine" and "black" alluding to the grape variety's tightly clustered dark purple pine-cone shaped bunches of fruit.

It is widely considered to produce some of the finest wines in the world. Pinot noir is also used in the production of Champagne and is planted in most of the world's wine growing regions for use in both still and sparkling wines. Pinot noir grown for dry table wines is generally low-yielding and of lesser vigour than many other varieties, whereas when grown for use in sparkling wines (e.g. Champagne) it is generally cropped at significantly higher yields. In addition to being used for the production of sparkling and still red wine, Pinot noir is also sometimes used for rosé still wines, and even vin gris white wines.

The leaves of Pinot noir are generally smaller than those of Cabernet Sauvignon or Syrah and the vine is typically less vigorous than either of these varieties. The grape cluster is small and conico-cylindrical, vaguely shaped like a pine cone. Some viticultural historians believe this

shape-similarity may have given rise to the name. In the vineyard Pinot noir is sensitive to wind and frost, cropping levels (it must be low yielding for production of quality wines), soil types and pruning techniques. In the winery it is sensitive to fermentation methods, yeast strains and is highly reflective of its *terroir* with different regions producing sometimes very different wines. Its thin skin makes it susceptible to bunch rot and similar fungal diseases of the bunch.

The tremendously broad range of bouquets, flavours, textures and impressions that Pinot noir can produce sometimes confuses tasters. In the broadest terms, the wine tends to be of light to medium body with an aroma reminiscent of black and / or red cherry, raspberry and to a lesser extent currant and many other fine small red and black berry fruits. Traditional red Burgundy is famous for its savoury fleshiness and 'farmyard' aromas (these latter not unassociated with mercaptans and other reductive characters), but changing fashions, modern winemaking techniques, and new easier-to-grow clones have favoured a lighter, more fruit-prominent, cleaner style. The wine's colour when young is often compared to that of garnet, frequently being much lighter than that of other red wines.

Cabernet Franc

Cabernet Franc is one of the major black grape varieties worldwide.



Cabernet Franc

It is principally grown for blending with Cabernet Sauvignon and Merlot in the Bordeaux style, but can also be vinified. Cabernet Franc is lighter than Cabernet Sauvignon, making a bright pale red wine and contributing finesse and a peppery perfume to blends with more robust grapes. Depending on growing region and style of wine, additional aromas can include tobacco, raspberry, bell pepper, and cassis, sometimes even violets.

In general, Cabernet Franc is very similar to Cabernet Sauvignon, but buds and ripens at least a week earlier. This trait allows the vine to thrive in slightly cooler climates than Cabernet Sauvignon. The vine is vigorous and upright, with dark-green, 5-lobed leaves. The winged bunches are elongate and small-medium in size. The berries are quite small and blue-black in colour, with fairly thin skins. The Cabernet Franc grapevine is more prone to mutation than Cabernet Sauvignon, less so than Pinot noir.

Cabernet Franc can adapt to a wide variety of vineyard soil types but seems to thrive in sandy, chalk soils, producing heavier, more full bodied wines there. The grape is highly yield sensitive, with over-cropping producing wines with more green, vegetal notes. Cabernet Franc shares many of the same phenolic and aroma compounds as Cabernet Sauvignon but with some noticeable differences. Cabernet Franc tends to be more lightly pigmented and produces wines with the same level of intensity and richness. Cabernet Franc tends to have a more pronounced perfume with notes of raspberries, black currants, violets and graphite. It is often characterized by a green, vegetal strike that can range from leaves to green bell peppers. It has slightly less tannins than Cabernet Sauvignon and tends to produce a wine with a smoother

mouthfeel. New World examples of Cabernet Franc tend to emphasize the fruit more and may delay harvesting the grapes to try to minimize the green leafy notes.

Cinsaut (Cinsault)



Cinsaut (Cinsault)

Cinsaut is one of those "grower" varieties that easily produces a very large crop of 6 to 10 tons per acre. At this crop level, it offers little sensory interest and imperceptible flavour distinction. So much cinsaut is overcropped and used as "filler" that it is difficult for many wine critics to issue it any respect. When properly managed to a crop load of just 2 to 4 tons per acre, it can produce quite flavourful wines with penetrating aroma and soft tannins, easily quaffable in their youth. Cinsaut is very drought resistant but can be susceptible to disease, so appreciates a dry climate. It produces large cylindrical bunches of black grapes with fairly thick skins.

The tight bunches rot easily, so it does best in drier climates. The cinsaut vine is fairly drought tolerant and has a fairly short growing season. With cluster stems that easily detach from the vine, cinsaut adapts well to machine harvesting. Large, black, thin-skinned, fleshy berries make cinsaut also attractive as eating grapes.

Wine made from cinsaut grapes can be very aromatic with a vaporous perfume that assails the nostrils and

supple texture that soothes the palate. Fairly low in tannin, it is often made into rosé by itself or blended, to brighten the fruit and tone down the harsher edges of carignan, in particular.

Pinotage



Pinotage

Pinotage is a red wine grape that is South Africa's signature variety. It was bred there in 1925 as a cross between Pinot noir and Cinsaut (Cinsaut was known as "Hermitage" in South Africa during that time, hence the portmanteau name of Pinotage). It typically produces deep red varietal wines with smoky, bramble and earthy flavours, sometimes with notes of bananas and tropical fruit, but has been criticized for sometimes smelling of acetone. Pinotage is often blended, and also made into fortified wine and even red sparkling wine.

The vines are vigorous like their parent Cinsaut and easy to grow, ripening early with high sugar levels. Yield restriction is managed through water stress and bunch thinning. In winemaking, controlling the coarseness of the grape and the isoamyl acetate character are two important considerations. Volatile acidity is another potential wine fault that can cause Pinotage to taste like raspberry vinegar. Since the 1990s, more winemakers have used long and cool fermentation periods to minimize the volatile esters as well as exposure to French and American oak.

The grape is naturally high in tannins which can be tamed with limited maceration time but reducing the skin contact can also reduce some of the mulberry, blackberry and damson fruit character that Pinotage can produce. Some winemakers have experimented with letting the grapes get very ripe prior to harvest followed by limited oak exposures as another means of taming the more negative characteristics of the grape while maintaining its fruitiness. Newer clones have shown some potential as well.

White Wine Grapes

Chardonnay

It is currently one of the most popular dry white wine varieties in the



Chardonnay

world. It is planted in almost every wine producing country and is one of the easiest varieties to grow. Chardonnay generally benefits from oak and is especially complex when it is barrel fermented as well as barrel aged.

Chardonnay is a green-skinned grape variety used to make white wine. It originated in the Burgundy wine region of eastern France but is now grown wherever wine is produced. For new and developing wine regions, growing Chardonnay is seen as a "rite of passage" and an easy entry into the international wine market. The Chardonnay grape itself is very neutral, with many of the flavours commonly associated with the grape

being derived from such influences as *terroir* and oak. It is vinified in many different styles, from the lean, crisply mineral wines of Chablis, France to New World wines with oak and tropical fruit flavours.

Chardonnay is an important component of many sparkling wines around the world, including Champagne. A peak in popularity in the late 1980s gave way to a backlash among those wine drinkers who saw the grape as a leading negative component of the globalization of wine. It remains one of the most widely-planted grape varieties.

Chardonnay has a wide-ranging reputation for relative ease of cultivation and ability to adapt to different conditions. The grape is very "malleable", in that it reflects and takes on the impression of its *terroir* and winemaker. It is a highly vigorous vine, with extensive leaf cover which can inhibit the energy and nutrient uptake of its grape clusters. Vineyard managers counteract this with aggressive pruning and canopy management. When Chardonnay vines are planted densely, they are forced to compete for resources and funnel energy into their grape clusters. In certain conditions the vines can be very high-yielding, but the wine produced from such vines will suffer a drop in quality if yields go much beyond 4.5 tons per acre. Producers of premium Chardonnay limit yields to less than half this amount. Sparkling wine producers tend not to focus as much on limiting yields, since concentrated flavours are not as important as the wine's finesse.

Harvesting time is crucial to winemaking, with the grape rapidly losing acidity as soon as it ripens. Some viticultural hazards include the risk of damage from springtime frost, as Chardonnay is an early-budding

vine – usually a week after Pinot noir. To combat the threat of frost, a method developed in Burgundy involves aggressive pruning just prior to budburst. This "shocks" the vine and delays budburst for up to two weeks, which is often long enough for warmer weather to arrive. Because of Chardonnay's early ripening, it can thrive in wine regions with a short growing.

Chenin Blanc

Chenin blanc is a white wine grape variety from the Loire valley of France. Its high acidity means it can be used to make everything from sparkling wines to well-balanced dessert wines, although it can produce very bland, neutral wines if the vine's natural vigour is not controlled. It provides a fairly neutral palate for the expression of *terroir*, vintage variation and the winemaker's treatment. In cool areas the juice is sweet but high in acid with a full-bodied fruity palate. In the best vintages the grapes can be left on the vines to develop noble rot, producing an intense, viscous dessert wine which may improve considerably with age.

The Chenin blanc grapevine buds early in the growing season and ripens late—traits that would make the



Chenin Blanc

vine more ideal in warmer climates rather than the cooler. New clonal varieties have been developed that delay budding and increase sugar development during the ripening phase. The vine is semi-upright in

habit with 3-5 lobed leaves. It tends to break bud early, with conical, winged bunches containing yellow-green grapes that ripen late. The berries are typically 16.0 mm long x 14.2 mm wide, with an average weight of 1.79g. The age of the vine can have an influence on wine quality, with older vines producing naturally lower yields.

The climate of a wine region will largely dictate whether Chenin blanc is produced in a predominately sweet or dry manner, while the vineyard soil type will generally influence the overall style of the wine. Heavy clay based soils, paired with the right climate, is favorable to the development of weighty, botrytized dessert wines that need time to age and mature. Well-drained and less organic, predominately sandy soils tend to produce lighter styles of wine that mature more quickly. Chenin blanc planted in soils with a high silex content will produce wines with distinctive mineral notes, while limestone based soils will encourage wines with sharp acidity. In areas where schist is plentiful in the soil, Chenin blanc grapes will generally ripen earlier than in vineyards with predominately clay based soils.

While true for most wine grape varieties, the quality of Chenin blanc wine is intimately connected to the care taken in the vineyard. If the grapes are harvested too soon, before they ripen, the high acidity of the resulting wine will be "one of the nastiest wines possible". If the grapes are harvested at too high of a yield, the grapes will not retain any of Chenin blanc's distinctive character notes. The vine is naturally vigorous and prone to overcropping if not kept in check. To keep yields in check, vineyard managers may choose to graft Chenin vines with less vigorous rootstock from *Vitis riparia* or *Vitis rupestris* vines.

During the growing season, they may also elect to do a green harvest where excess grape clusters are removed.

With optimal ripeness and balance between acidity and sugars being such a viticultural priority for Chenin blanc, many growers will harvest the grapes in *tries* or successive pickings through the vineyards. During each series of picking only the ripest clusters or individual grapes are harvested by hand during a period that could last four to six weeks and include three to six passes through the vineyard. For the production of sweet botrytized wines, pickers will look for the grapes that have achieved the necessary amount of the noble rot. In hot and dry years where no noble rot occurs, pickers may leave ripened grapes on the vine long enough to shrivel, where it could later be effected by noble rot. In areas that experience a lot of vintage variation, winemakers may decide on a day by day basis what style and dryness of Chenin blanc they could make, with the grapes harvested during each *tries* going to different styles of wine. The Late Harvest Chenin Blanc (technically a dessert wine) has a lovely golden hue and an underlying aroma reminiscent of honey and scorched almonds. It is mouth-filling, rich and sweet, but has retained enough edge to provide it with perfect balance.

Sauvignon Blanc

Sauvignon Blanc is a green-skinned grape variety which originates from the Bordeaux region of France. The grape most likely gets its name



Sauvignon Blanc

from the French word *sauvage* ("wild") and *blanc* ("white") due to its early origins as an indigenous grape in South West France, a possible descendant of savagnin. Sauvignon blanc is planted in many of the world's wine regions, producing a crisp, dry, and refreshing white varietal wine.

Depending on the climate, the flavour can range from aggressively grassy to sweetly tropical. Along with Riesling, Sauvignon Blanc was one of the first fine wines to be bottled with a screwcap in commercial quantities. The wine is usually consumed young, as it does not particularly benefit from aging. Winemakers in New Zealand and Chile harvest the grapes at various intervals for the different blending characteristics that the grape can impart depending on its ripeness levels. At its most unripe stage, the grape is high in malic acid. As it progresses further towards ripeness the grape develops red & green pepper flavours and eventually achieves a balance of sugars. The flavours characteristic of Sauvignon Blanc come from the chemicals *methoxypyrazines*.

Sauvignon Blanc can be greatly influenced by decisions in the winemaking process. One decision is the amount of contact that the must has with the skins of the grape. Prolonged exposure of the skins and juice will sharpened the intensity and pungency of the wine. Some winemakers, intentionally leave a small amount of must to spend some time in contact with the skin for later blending purposes. Other winemakers, generally avoid any contact with the skin due to the reduced aging ability of the resulting wine.

Another important decision is the temperature of fermentation. Some winemakers prefer warmer fermentations (around 16-18 °C) that

bring out the mineral flavors in the wine while New World winemakers prefer slightly colder temperatures to bring out more fruit and tropical flavours. Oak aging can have a pronounced effect on the wine, with the oak rounding out the flavours and softening the naturally high acidity of the grape. Some winemakers prefer stainless steel fermentation tanks over barrels with the intention of maintaining the sharp focus and flavour intensity.

Clairette

Clairette is a name used for several grape varieties in southern France. Light skinned Clairette Blanche and its pink skinned variant Clariette Rose are generally regarded as the true Clairettes. In the 17th, 18th and 19th centuries, Clairette Blanche was a important grape used in the production of maderised table wines



Clairette

and vermouth. However changing tastes and the move toward higher quality varieties led to the eventual decline in the style of white Clairettes is best suited for. However, Clairette producers have their attention to sparkling wines. It is high alcohol, low-acid variety that is only rarely produced as a varietal vine.

Complimented by floral notes and hint of honey, it is dominated by fruity aromas, ranging from peach, apricot and passion fruit. The mouth is

full, rounded with crisp acidity, and leaves and impression of freshness

NRC for Grapes

Chapter 3

Use of rootstocks in wine grape cultivation



Dr. J. Satisha
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The phylloxera outbreak in own rooted vineyards of *Vitis vinifera* grapes in Europe and the Napa Valley, in California, in the 1800s resulted in a search for new rootstock material for grapevines. While resistance to phylloxera was the primary criterion for selection of new rootstocks at the time, other recognised desirable attributes were ease of grafting, ability to root readily from cuttings in the nursery and appropriate growth, yield and fruit quality traits. The early work in Europe and the US was conducted over a wide range of soil and climatic conditions. In general, it was found that several species of North American grapes (e.g. *V. berlandieri*, *V. champinii*, *V. rupestris*, *V. riparia*) have characteristics that make them useful as rootstocks. Some are noted for phylloxera resistance, some for nematode resistance, some have special value as rootstocks in certain soils and others have properties such as drought tolerance.

With the advancement of rootstocks in different grape growing countries, many experimental trials have resulted in identifying rootstocks not only for overcoming the incidence of phylloxera and soil nematodes, but also for other abiotic and soil borne problems such as soil and water salinity, water scarcity, soil acidity etc. Some of the rootstocks are also known to alter viticultural traits such as controlling scion vigour, inducing

better fruitfulness, influencing fruit and wine quality etc.

Riparian and drought hardy rootstocks

Vitis riparia grows in alluvial soils and tolerates wetter areas. It has shallow roots, lower vigor compared to other species, and resists phylloxera. Originating in colder areas, the *V. riparia* is often more cold hardy than other species.

Vitis rupestris are deep rooted, drought tolerant, and resist phylloxera. However, the species has variable nematode resistance from plant to plant. ‘St. George’ is an example of a *V. rupestris* rootstock.

Vitis berlandieri is usually deep-rooted with some drought tolerance, and well adapted to high pH soils. *V. berlandieri* is difficult to root and is used in crosses with other species.

V. champinii survive in droughty areas with poor soils, so when planted in ideal sites with irrigation, it may be overly vigorous. These rootstocks are also sometimes less cold hardy.

If soil sample results show extremely high nutrient levels, a less vigorous rootstock or own-rooted plant should be used. Too much vigor can lead to excessive vegetation, resulting in fewer clusters, shading, and reduced fruit quality.

If vineyard soils are very heavy and hold too much moisture, a rootstock with a shallow root system such as 3309C may be beneficial just as a deep-rooted rootstock will be valuable in a sandy, droughty soil. Options for drought tolerant soils would be 110 Richter, 1103 Paulsen, and 140 Ruggeri. These three rootstocks can become too vigorous in well-irrigated vineyards.

There are several rootstocks for use in soils with high pH levels. Rootstocks with parentage from the *V. berlandieri* or *V. champinii* species would work well for high pH soils. Areas with salt accumulation can be planted with rootstocks that compensate for increased salinity. The 140Ru rootstock is a good choice to use in areas with elevated salinity levels.

Effect of rootstock on vine growth and development:

Vigorous rootstocks on deep soils produce very large vines. A low density of vines per acre with a wide spacing will add to that vigour too, and will quite probably present problems in ripening a large load of wood and fruit. A vigorous rootstock on a moderately deep soil in a high density of vines per acre will cause severe problems, the most likely being overcrowded, vegetative vines. In both cases abundant foliage growth will increase disease problems as well. Too little vigour in a low density planting will not fill the trellis properly, and become uneconomic; too little vigour in a high density vineyard may do the same, or actually cause early vine death.

Several studies both in India (mostly on table grapes) and other in other wine grape growing countries of the world have clearly indicated that rootstocks significantly affect scion vigour and productivity. Effect of

rootstocks on scion vigour and yield are very specific to scion/rootstock combination. Same scion grafted on different rootstock may exhibit different vegetative growth and yield pattern. Quality of fruits and wines is closely linked. Grape quality factors, which eventually determine wine quality includes soluble solids, organic acids, pH, phenolics and anthocyanins etc. Rootstocks have effect on quality of grapes with respect to acids, sugars, phenolic compounds, amino acids etc. This is more clearly studied in wine grapes than in table grapes as biochemical constituents play a major role in wine grapes than in table grapes.

Interaction between rootstocks and scions:

The way rootstocks interact with scions is a very complex and many of the studies could not establish clear mechanisms involved in rootstock scion interactions. The primary change after grafting or budding is the direct replacement of root system. Root anatomy and morphology, root development and their distribution may be different among rootstock species. The replaced roots will directly influence water and mineral uptake, which eventually influence growth of the shoot system and modify the scion physiology indirectly.

Important points to be considered while selecting rootstock for establishing vineyards for wine grapes:

- Pressure of abiotic stress factors in the prevailing region
- Climatic conditions
- Scion variety
- Soil type and properties
- Desired fruit yield and quality

- Training system and vine spacing
- Availability of irrigation water and its quality

Thus rootstock influence may affect scion vigor, yields, fruit and wine quality. These influences may be direct or indirect; positive or negative. The direct effect is caused by the function of root system and the indirect effect is due to the vine size modification. The performance of rootstock is always a site specific and compatible of a given scion/rootstock combinations may vary. It is always to be kept in mind that best wines of the world are produced on low to moderate

vigor rootstocks. It is important to adapt the rootstock choice to soil and climate to optimize the vine size. One should not use highly vigorous rootstocks in fertile soils, however, high vigor rootstocks can be of great value under very dry conditions and in less fertile soils.

Though systematic research on use of rootstocks in wine grapes under Indian conditions is not reported, long term field evaluation trial is in progress at NRC Grapes, Pune for evaluating seven different rootstocks viz., 110R, 1103 P, 140 Ru, Gravesac, SO-4, Fercal and 101-14 Mgt for Cabernet Sauvignon grapes.

Chapter 4

Training, Pruning and Canopy management practices in wine grapes



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Earlier, the grape cultivation was limited to table grapes only. The wine grape cultivation in India is of recent origin. In India, wine grape cultivation started from 2003-04. It is said that “the wine is made in vineyard”. Considering this, improved wine grape management through cultural means are given due importance. The practices consists of vine spacing, training of vines, pruning practices and other canopy management practices like bunch exposure, retention of bud load, shoot density, etc. plays an important role in production of quality wine. These practices are explained in details head wise.

Spacing:

The spacing in grape cultivation depends mainly on vigor of the vine. However, the quality wine depends on bud load available on vine. It is said that higher the bud load, poor will be wine quality. Considering this, minimum bud load per vine can be the answer. However, at the same time, yield per vine is also important, hence, the number of vines per hectare is given due importance in wine grape cultivation. Majority of the wine grape varieties are not vigorous as compared to the table grapes. Hence, the spacing allotted to each vine is less than the table grapes. Considering the mechanization requirement in the vineyards, soil type and also the quality of wine, the spacing in wine

grape ranges 7 feet to 8 feet between the rows and 3 feet to 4 feet between the vines. This helps in carrying out all the cultural practices during the season without compromising the quality of wine.

Training of wine grapes:

Proper training of young vines is essential for the establishment of a successful vineyard. The objective of vine training is to achieve a uniform framework of strong and healthy well shaped vines. To achieve healthy and strong framework, training needs to be given top priority from the initial stage of vineyard establishment. Attention must be paid to overall vineyard practices to ensure adequate growth and development of young vines.

Training of rootstock:

The rootstock training at the initial stage can help us to protect the future trunk from direct exposure from sunlight. Hence, the selected shoots before grafting needs to be trained to bamboo. This will help to obtain straight trunk with reserve storage of food material.

Training of grafted vines:

The trunk of grafted vine is tied with bamboo so as to train the trunk straight. This will help to reduce the dead arm on the trunk.

Training of primary arms: Immediately after the re cut, of grafted vines, the shoot grows vigorously. This

shoot should be pinched six inch below the first wire so as to train the primary arm in a slanting position. This will help to avoid direct sunlight exposure on the primary cordon.

Training of secondary arms (cordons):

Since the vigour of wine grapes is less than that of table grapes, the secondary shoots are trained to single cordons. The orientation of this cordon is horizontal so that the shoots are trained vertically on the cordons. This type of shoot orientation will harvest maximum sunlight required for fruit bud differentiation and thus the storage of food material will be enough to nourish the developing bunch.

Training systems used to train wine grapes:

Different training methods are being followed in training the grapevine. The method employed should be of more importance than we think. Many dozens of different training techniques have been developed, some of which have been in use for centuries in different countries where the wine grape cultivation is in practice. Grapevine is trained to achieve high quality production. There are number of training systems used worldwide, however, no single training system is appropriate for all situation. Based on the vigor, degree of vineyard mechanization and the availability of skilled workers, the selection of training system is decided. With the availability of reduced vigour in wine grapes, the training system plays an important role in quality wine production. Generally in wine grape production, very few training systems are in use. Among the major training systems, kniffin, telephone and mini Y system are prevalent in training of wine grapes.

Pruning of wine grapes:

The pruning can be defined as removal of plant parts to obtain appropriate number of fruiting units. The objective of pruning includes:

1. Controlling the size and form of a vine.
2. To increase more fruiting area on a vine.
3. Maintaining the balance between vegetative growth and fruiting.
4. Optimize the production potential of vine.
5. To obtain better quality fruit from the vine.

The pruning is done based on the weather available in that region. Under central parts of India, the vine grows vigorously throughout the year. Hence, double pruning pattern is followed for grape cultivation. The vines are pruned during April by leaving single bud on the cordon for. Since, the whole portion of cane, this pruning is called as back pruning. Fruit pruning is done during October for fruits, hence, it is also called as October pruning. During fruit pruning, the matured cane is pruned at 3-4 buds and is called as spur pruning. The canes are pruned leaving the buds on cane ranging from 3-6 depending on the fruitfulness on the cane. Different wine varieties behaves differently for fruitfulness, hence the pruning is done from 3-6 buds on the cane.

Canopy management practices for wine grapes:

Canopy management practices:

Canopy refers to the size and shape of vine structure. The size and shape of the canopy is dependent on canopy components such as primary

and secondary arms, canes, shoots and also on a given trellis/ training system.

The ideal canopy should fulfil the following requirement:

- i. It should give the grapevine a desirable shape and support the load of canopy.
- ii. It should offer scope for convenient operations in the field and mechanization.
- iii. It should have adequate number of fruiting units.
- iv. It should allow sufficient light and ventilation into the canopy during the growth season.
- v. It should offer scope for effective spray coverage with pesticides and growth regulators.
- vi. It should not build up micro-climate that is congenial for disease development.

Canopy management refers to the practices followed to obtain the ideal characteristics in various canopy components to realize the maximum yield of export quality grapes. The requirement of canopy during each pruning under tropical region is as below.

Canopy management practices followed after foundation pruning:

- i. Shoot thinning is to be done at 4-5 leaf stage only. This helps in reducing the loss of nutrients from the vine.
- ii. The number of shoots retained on vine should be 0.70 per ft² for export quality however, it can be one per ft² as it is followed in case of table grapes.
- iii. The canopy should be open during April-September so that enough sunlight harvesting required for photosynthesis can be achieved.

- iv. The shoots on each cordon should be vertically positioned to harvest maximum sunlight required for fruit bud differentiation.
- v. While removing the excess shoots from the cordon, remove both vigorous and weaker shoots so that all the shoots will be uniform in diameter. This will help for uniform bunch appearance after fruit pruning.
- vi. Top the side shoot at 10-11 leaf stage on a shoot. This helps to store enough food material, reduce vigor and advance cane maturity.

Canopy management practices followed after fruit pruning:

- i. Collect the canes of different category and examine the buds under microscope for fruit bud differentiation in cane. This helps in deciding the actual position of fruitful buds so that the decision on fruit pruning can be taken up.
- ii. The canes of 6 mm and less diameter are to be removed during fruit pruning.
- iii. Swab hydrogen cyanamide only to apical 2-3 buds on each cane. This helps in early and uniform bud break.
- iv. Based on the bud break and the bunch emergence, shoot thinning is to be followed at 4-5 leaf stage.
- v. Depending on the requirement, bunch thinning should be followed at pre- bloom stage only.
- vi. Retention of bunches to be done based on the spacing allotted to each vine.
- vii. Encourage the shoot growth by applying more nitrogen and water until one month after fruit set.

- viii. Position the shoots to provide shade to the bunches on the South-West side of the canopy.
- ix. Shoot topping is done at 10-12 leaf above bunch after forward pruning to avoid competition for nutrients by the shoot and consolidate the food material in the developing bunches. This helps in increasing the berry size.
- x. In case of white varieties, harvesting to be done at 24°Brix TSS, 0.5 to 0.7% acidity and 3.4 to 3.6 juice pH.
- xi. In case of red wine, harvesting to be done when the bunches have attained complete colour, required TSS, acidity ratio of 30 and juice pH 3.5.
- xii. The harvesting should be done generally in the morning hours.
- xiii. The disease infected bunches should be removed before crushing.

Chapter 5

Nutrient and Water Inputs – Wine Grapes



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The wine grapes are generally smaller in size, seeded, relatively thick skinned and sweeter in taste compared to table grapes which have large berry size, physically desirable in looks with thin skin. Further, the crop load is low for wine grapes. The input management strategies differ between the two. Wine grape cultivation in India falls under hot climate, a category based on average growing season temperature (Jones, 2006). It is envisaged that climate change is likely to bring hotter growing season with less rainfall. Such events will increase both water and salt stress to plants and may also lead to vine mortality. Further, the problem of salinity becomes all the more important in the coloured wine varieties as the grape skin is fermented for substantial period and these are important sink for ions.

Grape vines once planted stays at the site for period of 15-20 years. Favourable rooting environment and proper understanding of the phenology of vine is key to efficient water and nutrient management. Nutrient availability to plants is dependent upon soil pH and its composition, amounts of nutrients in the soil and soil environment (Table 1). Apply fertilizer based on soil and petiole test report. The nutrient input from organic manures and irrigation water should also be taken into consideration while deciding the quantity of nutrients to be applied at specific crop growth stage.

Assessing vine nutrient needs:

Normally, potassium, magnesium, iron, zinc and sometimes boron deficiencies are observed in our vineyards. Apart from these, toxicity of sodium can also be observed due to saline irrigation water containing sodium more than 100ppm. Visual symptoms of nutrient deficiencies/toxicities are given in Fig.1. Regular soil testing can determine status and changes in soil composition and any toxicity, which may impede nutritional balance. But, grape roots being spread deep in the soils, vines may not respond to the fertilizer application as predicted by soil testing, hence, petiole testing becomes very important.

The petiole samples should be drawn during both foundation and fruit pruning seasons and sent for analysis to a recognized laboratory in order to know the nutrient status for vegetative growth and fruiting respectively. It is therefore, very important to do petiole testing for proper diagnosis of the nutrient needs of the vine. Petiole testing should be done at fruit bud differentiation stage in the foundation pruning season and at full bloom and veraison stage in the fruit pruning season. At fruit bud differentiation stage, fifth leaf from the base of the shoot is selected for sampling. The petiole to be sampled should be opposite the cluster at full bloom stage (Fig.2).

The petiole analysis at veraison gives the correct status of the nutrients especially in relation to macronutrients in comparison to the full bloom stage. The leaf to be sampled should be fully matured middle leaves present on the shoot after bunch and should be done at 50% veraison stage. In case of suspected nutrient deficiency, collect petiole samples from vines showing leaf symptoms and from vines without symptoms (healthy or normal). The two samples are sent and analyzed separately for comparison purposes. This will allow you to diagnose whether or not the problem is related to nutrient status of the vine.

Presently, wine grape petiole standards are in the process of development in our country as wine grape cultivation is still in infancy. Nevertheless, the standards presently being used in Australia (Table 2) could serve the purpose for the time being. These standards have been developed for optimal crop growth and not for specific quality grape production. Further, the nutrient standards might change based upon the rootstock used, soil type and its fertility status, management practices and targeted yield. The rootstock differences in uptake of nutrient levels are given in table 3. Studies carried out at NRC Grapes have revealed that for Cabernet Sauvignon vines raised on 110R rootstock apply 150kg N, 100kg P₂O₅ and 350 kg K₂O on per hectare basis including both organic and inorganic sources (fertilizers). Farm yard manure from commercial dairies; add substantial quantity of nutrients to the soil. Hence, nutrient contribution from organic sources like FYM should be considered while finalising nutrient schedule to avoid over fertilization. The detail application schedule is given in Table 4. Further, irrigation water particularly from groundwater sources can supply large quantities

nutrients to meet crop needs of nutrients like nitrogen (nitrate-N), Mg and calcium etc. For example- if irrigation water contains 20 ppm nitrate-N and about 20,00,000 liters of irrigation water is applied per hectare in a year it will add 40 kg N as nitrate-N. Hence dose of nitrogenous fertilizers should be adjusted accordingly.

Amongst different nutrients potassium and Fe deficiencies are most commonly observed in majority of the vineyards. The deficiencies of other nutrients are rare or less common under the current package of practices followed in Indian vineyards.

Assessing irrigation needs for the vineyard

Water is a critical input for grape production. The manner in which irrigation is managed is crucial to grape quality. For proper wine quality the irrigation needs to be regulated. The amount of irrigation to be applied depends on rainfall, soil and water quality. Further, quality of water in terms of salinity, presence of specific ion (Sodium, Chloride, Boron, Nitrate etc.), carbonates and bicarbonates will have an impact on the quantum of water required for the vine cultivation as well as on the nutrient requirement based on vine phenology. Studies at NRC Grapes of Cabernet Sauvignon raised on 110R rootstock indicated that the irrigation schedule treatment with least irrigation water application of 182.81 mm apart from 192 mm of rainfall has been found to provide yield and quality of the Cabernet Sauvignon grapes comparable to treatments with higher irrigation water application. The Water use efficiency of 103.42 kg of grapes/ mm of irrigation water applied was recorded in this irrigation schedule. Experimental findings for Indian

conditions are lacking with respect to wine quality, however, the finding in different parts of the world are given here. Grape quality is largely determined by the composition and size of the fruit. While large size is an important quality factor for table and raisin grapes, small size is preferred for wine grapes, particularly for the red wine grapes since fermentation is conducted with the skins. Small grape size (large surface to volume ratio) is preferred since the dermal tissue (skin) contains most of the color and flavor-producing compounds. Clearly, smaller grapes are produced on vines that experience water deficits than on vines that are continually without stress. The concentration of sugars in wine grapes determines the final alcohol content and its influence on wine flavor. Wine grapes typically contain 21 to 24 % fermentable sugar at harvest. Harvesting after this level of sugar is reached tends to reduce total yield by increasing the number of dry grapes (raisins).

The accumulation of sugar is much less sensitive to water deficits than is fruit growth. Hence, irrigation generally increases yield while frequently having little effect on sugar concentration. The acid level in grapes is important to balance the acidity of the wine. A moderate decrease in titratable acidity was observed where plant water status indicated significant water deficits. Some researchers found that wines from high water level vines were lower in alcohol, extract total polyphenols, color intensity and pH and higher in titratable acidity than vines which experienced some degree of water stress. In addition to laboratory analysis, sensory evaluation detected differences in color, aroma, body, taste, astringency and general quality between wines from continuously unstressed vines and those that were stressed after veraison.

Over stressing the vines as is being presently followed by many growers in Maharashtra has resulted in reduced productivity.

The winemaking potential of the grape will suffer in the cases of both no water deficit and excessive water stress. Deficit irrigation should never be practiced on young vines that have not yet begun to fruit. So the first trick is figuring out when to begin irrigating. This really depends on your soil, your rootstock/variety combination, and your rooting zone. Generally the vine begins to experience a sufficient water deficit when they have used up about half of the available moisture in the rootzone. The quantity of irrigation water to be given to Cabernet Sauvignon vines raised on 110R rootstock is given in table 4 based upon crop growth stage and pan evaporation. However, the grower needs to take into account his soil type to work out the allowable water depletion before the vines are stressed. In general, the total available water content of the soils should be exhausted upto 50% before irrigation is applied. The allowable depletion based upon soil texture is given in table 5.

When to irrigate the vineyard:

Normally, the timing of irrigation should take into account the pan evaporation reading, crop growth stage, soil type and the irrigation system. In general, the irrigation system in grower's vineyards are surface drip irrigation system. With 90 % of the roots concentrated upto 60 cm depth, this can be taken as effective rooting depth for wine grapes.

Example: Cabernet Sauvignon vines are planted at a distance of 4 feet with row to row spacing of 8 feet. The soil in the rooting depth (60 cm) is clayey

soil. Calculate the days to irrigate the crop if the soil is at field capacity with total available water of 0.16%. The crop stage is berry growth (56- 90 days) with pan evaporation of 3 mm.

The effective root zone with vine to vine spacing of 1.2m, lateral spread of 0.9m and rooting depth of 0.6m is equal to 0.65 m³.

From table 5, the allowable water depletion for clay soil in the root zone is 52 L out of 104 liters of available water

Pan evaporation = 3mm

Irrigation requirement at berry growth stage is 4500L/ hectare

With spacing of 8ft x 4 ft, the total vine population in one hectare area = 3363

Irrigation requirement per vine at berry growth stage (Nov. to Jan.)= 1.4 L/ vine/ day

Days to reach allowable depletion for clay soil = 4500L /1.4L =37 days

So irrigation should be started after 37 days.

Table 1: Guidelines for Interpreting Soil Suitability for Grapes

Possible problem and unit of measurement	No problem (less than 10% yield loss expected)	Increasing problems (10 to 25% yield loss expected)	Severe problems (25 to 50% yield loss expected)
pH	5.5-8.5	-	-
Salinity E _{Ce} (mmhos/cm)	1.5 to 2.5	2.5 to 4	4 to 7
Permeability ESP (est.)	Below 10	10 to 15	Above 15
Toxicity			
Chloride meq/l	Below 10	10 to 30	Above 30
Boron mg/l or ppm	Below 1	1 to 3	Above 3
Sodium (meq/l)	--	Above 30 (690 ppm)	--
NOTE: Guidelines are flexible and should be modified when warranted by local practices, experience, special conditions. Interpretations are based on chemical analyses of the soil saturation extracts from soil samples representing a major portion of the root zone—usually the top 2 to 3 feet of soil			
Source: Peacock and Christensen Interpretation of soil and water analysis			

Table 2: Petiole nutrient standards for flowering stage

Element	Deficient	Marginal	Adequate	High	Toxic or Excessive
% of dry matter (g/110 g dry matter)					
N			0.8-1.1		
P	< 0.2	0.2-0.24	0.25-0.5	> 0.5	
K	< 1.0	1.0-1.7	1.8-3.0		
Ca			1.2-2.5		
Mg	< 0.3	0.3-0.39	> 0.4		
Na					> 0.5
Cl					> 1.5
mg/kg of leaf dry matter					
Mn	< 20	20-29	30-60		> 500
Zn	< 15	15-25	> 26		
Cu	<3	3-5	6-11		
B	< 25	26-34	35-70		> 100
Fe			> 30		

Source: Nutrient standards. Adapted from Reuters and Robinson (1997) Reuter DJ and Robinson JB (Eds) 1997 Plant analysis: An interpretation manual. Inkata Press, Melbourne.

Table 3. Ranking of *Vitis* rootstocks for average bloom petiole values of NO₃-N, P, K and Zn

Nutrient	High	Medium	Low
NO ₃ -N	039-16, Freedom, St. George, Ramsey	101-14 Mgt, 5BB, 1103P, 3309C, Schwarzmann, 44-53M, 110R	Harmony, 5C, 1616C, 420A
P	110R, 1103P, Ramsey, Freedom	Harmony, 5C, 5BB, 039-16, Schwarzmann	St. George, 420A, 101-14Mgt, 3309C
K	Freedom, St. George, Schwarzmann, 44-53M, 1616C, Harmony, 039-16, 101-14 Mgt	5C, 5BB, Ramsey, 3309C	1103P, 140Ru, 110R, 420A, 5A
Zn	<i>Vitis vinifera</i> (own root)	110R, 3309C, 101-14 Mgt, 5BB, 5C, 1103P, 420A	039-16, Freedom, Ramsey, Harmony

Source: Christensen, Peter, Monitoring and Interpreting Vine Mineral Nutrition Status for Wine Grapes, 2001.

Assessing Vine Nutrient Needs Erica Lundquist
<http://www.lakecountywinegrape.org/growers/nt-nutrient.php>

Table 4. Irrigation schedule based upon pan evaporation and fertigation schedule for various growth stages of Cabernet Sauvignon vines raised on 110R rootstock using saline irrigation water (1.9- 2.0 dS/m)*

Growth Stage	Expected duration (days after pruning)	Water requirement (litres/day/hectare per mm of evaporation)	Month of operation	Expected monthly Pan evaporation (mm) in different grape growing regions	Approximate water (litres /hectare/ day)	Nutrient application (kg/ha)		
						N	P ₂ O ₅	K ₂ O
Foundation pruning								
Shoot growth	1 - 40	3000	March-April	8 to 12	24000 - 36000	75	50	31
Fruit bud differentiation	41 -60	1500	April-May	8 to 10	12000 - 15000			31
Cane maturity and Fruit bud development	61 - 120	1500	May - July	6 to 10	9000 - 15000	-		31
121days - fruit pruning	121 -	1500	July - Sept	0 to 6	0 - 9000	-	-	31
Fruit Pruning								
Fruit pruning								
Shoot growth	1 - 40 days	3000	Sept - Oct	6 to 8	9000 - 24000	75	50	31
Bloom to Shatter	41-55	3000	Oct - Nov	4 to 6	12000 - 18000	-		31
Berry growth and development	56 - 90	1500	Nov. - Jan	3 to 6	4500 - 9000		-	33
Berry growth and development	91-105	0	Jan	3-6	0			
Ripening to Harvest	106 - 145	1500	Jan. - Mar	3 to 10	0	-	-	31
Rest period	Harvest to Foundation pruning (20 days)	-	March	8-10	-*			-

** The schedule has been worked based on experiments in heavy and calcareous soils and therefore this may be taken as guidelines to apply irrigation and nutrients at different growth stages. The above mentioned irrigation and fertigation schedule can be taken as tentative guideline for Sauvignon Blanc on 110R rootstock also.

Note:

- One kg P=2.29 kg P₂O₅ and one kg K= 1.21 kg K₂O
- Depending on water quality, the amount of water needed may change. Irrigation should not be applied after the soil has reached field capacity after rain.

- Irrigation requirement will be less by 20% compared to above given schedule if low salinity water (EC less than 1.0 dS/m is used).
- The above nutrient values are the guidelines for distributing the NPK doses values may change based on the site and climatic conditions.
- Under normal climatic conditions generally, it takes 10-12 days for sprouting.
- The nutrient applications should necessarily take into account soil, petiole and water testing report.
- Contribution of nutrients from other sources like composts, FYM, green manuring irrigation water, etc. should also be taken into consideration for adjusting the nutrient dose. All the manures and fertilizers, irrigation water and other inputs should be tested for presence of heavy metals (As, Cd, Co, Cr, Cu, Hg, Mn, Ni, Pb, Sn, and Tl) before use.

Table 5: Allowable water depletion based upon soil texture

Soil Texture	Total Available Water (%)	Total Available Water (litre/vine rooting volume)	Allowable water depletion without stress (litres in rooting volume of one vine)
Sand	0.08	52.00	26.00
Loamy sand	0.09	58.50	29.25
Sandy loam	0.13	84.50	42.25
Loam	0.16	100.75	50.40
Silt loam	0.16	104.00	52.00
Silt	0.18	117.00	58.50
Silt clay loam	0.16	100.75	50.40
Silty clay	0.16	104.00	52.00
Clay	0.16	104.00	52.00

Rooting volume for 8 ft x 4 ft spacing with a depth of 60 cm is 0.65 m³.

Source: FAO



Potassium deficiency symptoms in Cabernet Sauvignon vines



Potassium deficiency in Shiraz vines



Potassium deficiency in Vignier vines



Boron toxicity in Cabernet Sauvignon vines



Potassium deficiency and sodium toxicity in Cabernet Sauvignon vines raised on Dogridge rootstock



Magnesium deficiency in Shiraz vines



Interveinal chlorosis and necrosis caused by Fe deficiency in Cabernet

Fig. 1. Visual diagnosis of nutrient deficiencies



Fig. 2. Petiole for sampling leaf position at flowering stage

Chapter 6

Use of bioregulators for improving quality of wine grapes



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Numerous growth regulators are being used in grape cultivation to increase its productivity and quality. Hormonal balance in any plant system is as delicately interwoven and as distinct as a spider web. Any imbalance created in the hormonal system by injudicious usage of the growth regulators will collapse the entire plant system. So one has to use very judiciously and cautiously these growth regulators, not to cause any disturbance in the delicate balance of the endogenous hormones and the physiology of vines as a result of that specific hormonal composition of the system. Effects of exogenous plant growth regulators have been investigated more on seedless varieties but relatively less on seedy varieties. Also, little experimental evidences demonstrated the use of growth regulators in improving quality of wine grapes. French hybrid wine grape, de Chaunac used to produce dry red dinner wine when grown in interior valleys of southern British Columbia. It is prone to over-cropping which is attended by lowered juice quality, greater vulnerability to cold injury, and reduced glowering and vine yields. However, GA₃ was found to be the most promising growth regulator for increasing weight of the individual Chaunac berries and improved juice quality performed cluster thinning along with the foliar sprays of Chloromequat (CCC @ 500 ppm) and GA₃ (50 ppm) to Chaunac grapes at prebloom and full bloom stages

respectively. Their results revealed that CC treatment increased berry set on thinned and unthinned vine but reduced berry size (weight) and juice quality. On the other hand, gibberellic acid reduced berry set, increased berry weight and improved juice quality.

Grape quality largely depends on various metabolites present in berries is of crucial importance to wine industries. Phenolic compounds in grapes are essential for the quality of wine because they are associated with red wine colour and involved in oxidative processes of white wines and also contribute to taste by providing bitter and astringent properties. Recently, Balint and Renoylds, (2012) conducted two experiments to study the effects of exogenous abscisic acid (ABA) on vine physiology and grape composition of Cabernet Sauvignon in Ontario. The first experiment was initiated one week preveraison with three treatments (300 mg ABA/L was applied to the full canopy, clusters only and leaves only), applied three times at two-week intervals while in the second experiment 150 and 300 mg ABA/L applied to clusters only. Their results revealed that at harvest, Brix was higher and the berry weight was lower in ABA treatments than the control. In addition, total anthocyanins and total phenols also increased in most ABA treatments. Moreover, berries from clusters treated with the highest ABA rate showed a higher red- blue color

intensity and also had highest anthocyanins and phenols compared to berries from other treatments. Additionally the treated vines showed enhancement in individual anthocyanins and acetylated anthocyanins, with significant changes in the ratios of cyanidin, petunidin and malvidin occurring among the treatments. Exogenous ABA was effective in accelerating onset of veraison and improving the grape composition of Cabernet Sauvignon. Furthermore, they concluded that, exogenous ABA could provide considerable benefits to the wine industry in terms of grape composition, wine style and for winery scheduling, particularly in wet and cool years. Likewise, Avizcuri-Inac et al (2013) studies the effects of prohexadione calcium (ProCa) applications on Phenolic composition and sensory properties of red wines, Tempranillo and Grenache. The application of ProCa given at prebloom stage

resulted into reduced berry size and berry weight while an improvement in wine quality was observed. Similarly it would be necessary to understand and assess effects of several other growth regulators not only on general vine metabolism and physiology, but also on wine quality.

Quality improvement in wine grapes is aimed at the production of loose bunches, increase in its sugar content and juiciness. While using growth regulators for quality improvement, it is to be borne in mind that growth regulators bring out improvement in quality through changing the growth or diverting the flow of metabolites into the berries, but do not increase the quality parameters by themselves directly. They are the mediators. The basic requirements are the metabolites, i.e. the carbohydrates or proteins in the plant system. In the absence of these metabolites in the plant system, use of growth regulators cannot bring about the desired effect..

A. Foundation pruning:

Sr. No.	Growth Stage	Chemical	Concentration
1	After pruning	Hydrogen cyanamide @	1.0-1.5%
2	45 days after pruning	Uracil	50 ppm

B. Forward pruning:

Sr. No.		Growth Stage	Chemical	Concentration
1	1	After pruning	Hydrogen cyanamide	1.0-1.5%
2	21-24	Prebloom spray	Gibberelic acid	15 ppm

Bio-regulators use is very limited in grapes, however it can be used for various purposes viz. inducing bud break apart from increasing rachis elongation for production of well filled bunch. Bioregulators with their nomenclature, doses, stage of

application, care to be taken during application have been elaborated pointwise in the above table.

Budbreak

After Backward and Forward pruning, hydrogen cyanamide @ 1.0-

1.5 per cent a.i. (20-30 ml/L active ingredient is 50%) can be used within 2 days of pruning as per thickness of the cane to increase the budbreak and also the uniformity in the budbreak. For achieving more uniformity in budbreak, only selected buds has to be treated with hydrogen cyanamide.

Cluster elongation

Clusters are treated with Gibberellic acid (GA₃) for cluster elongation. For this purpose, GA₃ @ 15 ppm can be given as a spray during prebloom stage for rachis elongation and cluster growth.

Practices to produce loose bunches

Do's

- i. Spray GA₃ @ 15 ppm at prebloom stage of cluster
- ii. GA₃ spray solution should be acidic (pH 5.5 - 6.5). Use citric *or* phosphoric acid *or* urea phosphate as an adjuvant to lower down the pH of spray solution
- iii. Use sufficient spray solution to have optimum coverage of foliage as well as clusters.

Don'ts

- i. Do not use the solvent (acetone / methanol) more than 30 ml per g of GA₃.

- ii. Do not spray pre-bloom GA₃ without fungicide if the weather is cloudy and humid, particularly if it is likely to rain to avoid excessive flower drop.

Increasing sugar content of berries

Do's

- i. Orient the shoots so that all leaves are exposed to sunlight and the vine canopy is well illuminated and ventilated
- ii. Remove the weak canes at forward pruning
- iii. Ensure adequate leaf area per bunch.
- iv. Restrict the shoot growth to have not more than 15 leaves/bunch
- v. Remove the basal yellow leaves

Don'ts

- i. A void over-crowding of shoots and natural shading of leaves.
- ii. Avoid excessive irrigation after berry softening.
- iii. Do not allow the clusters on weak shoots.

Chapter 7

Disease management in wine grapes



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Downy mildew, powdery mildew and anthracnose are the three important diseases caused by fungal pathogens and require warm and wet / humid conditions for causing infections. During monsoon, downy mildew and anthracnose are the major diseases noticed on the leaves, while powdery mildew appears when there is a long gap of rain with cloudy conditions. Rust infection appears on old leaves usually during August and September.

Foundation pruning in wine grapes is done from the end of February or in March as fruit pruning is to be done in September for early crop maturity. From March to first week of June usually the climate is hot with temperature ranging from 35-40°C and dry with relative humidity > 40%, hence there is least possibility of development of any disease. However diseases occur during monsoon period when rains are received any time from second week of June till middle of

October. In most grape growing areas 300 to 500 mm rain is received annually and there are about 30-45 days recording more than 4 mm rain per day from June to October.

By the time monsoon sets in, majority of the canes would have developed more than 12 leaves and shoot growth is normally brought under control. In the absence of growing shoots, application of non-systemic fungicides can give equally good results. Copper fungicides in general are broad spectrum and have good rain fastness, thus show good results during wet conditions. During September it rains in most of the grape growing areas and as a result of this diseased leaves drop off early. Accumulation of chlorides and salts in general, in saline areas also lead to early leaf drop. Strategy of disease management after back pruning is, therefore, aims at providing protection during wet weather, to reduce the disease on the first 12 leaves of the canes and to make them stronger to resist drop till forward pruning.



Grape leaves showing oily spot symptoms of downy mildew



Growth of downy mildew on lower surface of the leaf

Wine grapes need to be ready for harvest during January and February, as fruits matured in mild temperature are better for wine making. Hence, preferred time of fruit pruning in wine grapes is during September. However, it can extend till third week of October, based on rain forecast and risk of downy mildew. From disease management point of view, forward pruning taken before 15th of October has greater risk of downy mildew, as there are more chances of rains and temperature is warmer. After forward pruning, about 10-12 days are needed for sprouting of buds. Thereafter on an average every three days interval new leaf is developed. At fifth leaf there will be a bunch, which takes about 35 days from fruit pruning to develop to flowering stage and by 50 to 55 days fruits set in. First 50 to 55 days after pruning, risk of damages due to downy mildew infection on bunches is very high. Rains and heavy dew during this period helps development of downy mildew on bunches. Leaf wetness for continuous period of three hours after sunrise is favourable for new infection. If such conditions prevail during first 55 days of pruning, sprays of fungicides are needed at shorter intervals for effective control of downy mildew. Berries develop to 10 to 12 mm size within first 70-75 days of forward pruning and thereafter the risk of downy mildew gradually reduces. Rains during November and December are rare, but in years when it rains during November or thereafter, heavy losses due to downy mildew are observed. Normally, 5 to 6 sprays of fungicides are required during first 55 days of pruning for effective management of downy mildew. This number of sprays may be increased to 9 in the event of rains during November- December, while it can be

reduced to 3-4 when wet weather is absent after forward pruning.

Details of chemicals, their doses, PHI, MRLs are given in Annexure I.

The list given in Annexure I was primarily prepared for table grapes. It may be considered applicable to wine grapes too. However, following points may be given due consideration.

1. Sprays of fungicides given before fruit set usually do not appear in residue at harvest.
2. Use of triazole fungicides for powdery mildew management after fruit set should be done only if weather conditions indicate high risk of disease. Fungicides with PHI more than 40 days, such as flusilasole, penconazole, and triademefon should be used within 60 to 70 days of fruit pruning. While, Hexaconazole and myclobutanil should be used till few days are left for veraison.
3. Use of strabularin fungicides such as Azoxystrobin, Kresoxim methyl, should be avoided for the management of powdery mildew.
4. For the management of powdery mildew after veraison following can be used
 - a. Spray Sulphur 80WG, 1.25 g / L till 15 days before harvest
 - b. Spray formulation of *Basillus subtilis*, or *Pseudomonas fluorescense*, or *Trichoderma*. Apart from biological control of powdery mildew these organisms could be helpful for bio-degradation of pesticides present of berry surface.
 - c. Spray irrigation water.

How to take decision on “what to spray?” and “when to spray?”

When new infection of downy mildew occurs?

Infection of downy mildew takes place when leaf, bunch or cane is wet during day time at least for 2.5 to 3.0 hours. Such condition is present when it rains or RH is very high after rains and fog or dew remains for long time in the morning.

Preventive spray is needed when new infection is likely

The vineyard needs to be protected when new infection of downy mildew is likely to take place. Therefore, 10 days onwards, after fruit pruning the grower is expected to watch the vineyard for presence of dew on leaves and bunches, every morning. If the temperature is above 10 °C, and dew is present on leaves after 9.0 am, the resulting leaf wetness period is sufficient to complete the process of new infection. Under such situation make your own observations on the following

- Whether the last spray of systemic fungicide for control of downy mildew was given within 3-4 days?
- If not, spray is required.
- If the spray was given within last 3-4 days, even though leaf wetness is present, spray may not be required till about 4 days have passed after this spray.
- However, decision can be taken based on
 - i. Weather forecast e.g. If it is likely to rain within a day or two spray can be preponed
 - ii. Presence of active inoculum of downy mildew in close vicinity e.g. if the oily spots (Photo) of

downy mildew are seen in same or in nearby vineyard immediate spray may be needed.

Weather forecast helps in scheduling sprays

Location specific weather forecast for next 5 to 7 days is now a days available on internet. Information on forecast of rain is often useful in scheduling sprays, especially during critical stages of growth. In most cases rainy condition lasts for 2 to 3 days. Preventive spray given before rains often protects vineyard from downy mildew for 2 to 3 days of rainy condition. Even if new downy mildew infection takes place, its establishment and appearance of first symptom such as oily spots and subsequent sporulation needs at least 3 days after infection. This means if the preventive



Powdery mildew symptoms on berries - pigmented web-like appearance on surface

spray is given just before rains, the grower can safely wait for 3 to 4 days of rainy weather and give subsequent spray only after rains have stopped. However, this can be effectively done when location specific weather forecast is available.

NRC for Grapes, Pune gives summary of weather forecast of 7 days, for major grape growing areas on their web site. <http://nrcgrapes.nic.in/>

On this website click on menu “**Weather forecast based grape advice**” to get the weather forecast and related advice on plant protection. To know more details on weather at location of your interest one can see different links given on this page.



Rust infection on leaf of Thompson seedless

Note: Above weather information is summary of weather forecasting given in following websites

<http://www.weather.nic.in/current.htm>

<http://www.imd.gov.in/section/nhac/wch/todaywch.htm> ,

<http://www.imd.gov.in/section/nhac/distforecast/INDIA.htm>

<http://wxmaps.org/pix/prec6.html>

<http://www.accuweather.com/world-forecast.asp?partner=accuweather&traveler=0&locCode=ASI|IN|IN021|JUN NAR&metric=1> ,

<http://fallingrain.com>

Important risk periods for downy mildew

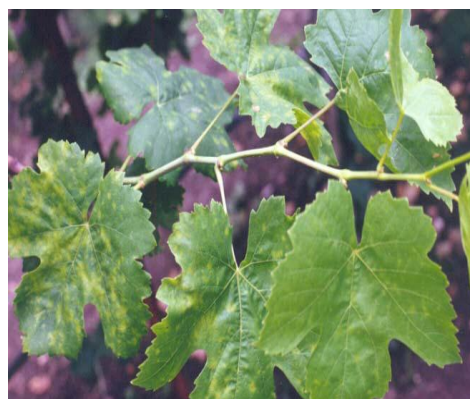


Characteristics symptom of anthracnose on leaf showing shot hole

While taking decision on sprays for downy mildew, growth stage related risk needs to be taken in to consideration.

First 50 days of forward pruning, especially after 10 days of pruning are important for management of downy mildew.

10 to 25 days after pruning new shoot is slowly growing. The vine receives N fertilizers during this period. To protect new shoots, two preventive sprays of systemic fungicides for downy mildew, preferably belonging to Low risk group as per Fungicide Resistance Action Committee (FRAC) classification, are required.



Powdery mildew symptoms on leaves showing shiny chlorotic spots

26 to 35 days after pruning :

Young light green coloured bunch is just visible, and rapid elongation of cane is visible. Application of GA as spray or bunch dip, for bunch rachis elongation, is given during this period. GA application makes shoots and bunch more succulent and more sensitive to downy mildew. Two more preventive sprays of systemic fungicides for downy mildew are required during this period too.

36 to 50 days after pruning :

After about 35 days after pruning the flowers in the bunch start opening. When flower cap starts separating, it allows dew water to accumulate and remain on bunch for longer period. This leads to bunch infection of downy mildew even when weather is not very suitable for downy mildew. In case of mild infection losses could occur due to flower drop or by drying off of bunchlets. Hence, during this period 1

or 2 additional preventive sprays of systemic fungicides for downy mildew are required.

Care needed if it rains during December

By December most vineyards will have progressed beyond flowering and berry setting stage. In the event of normal weather, it rarely rains during December. Most grape growing areas in Maharashtra, Andhra Pradesh, and Karnataka temperatures will have considerably reduced and night temperatures will be close to 10°C.

Whenever, wet weather and young growing shoots are present there is a risk of downy mildew and anthracnose. High humidity, moderate temperature, and low light intensity due to crowded canopy or due to cloudy conditions increase the risk of powdery mildew.

After foundation pruning (April to October)

Days after pruning or growth stage	Control measure for disease
Pre-pruning period	<p>Downy mildew</p> <p>Collect all downy mildew infected and dried bunches, leaves and canes from the vineyards before back pruning and burn them. Such operation may be essentially needed in vineyards with known attack of downy mildew during previous fruiting season.</p> <p>General</p> <p>Dead, dried wood present on arms, and dried bunches hanging on vine, should be removed and cut surfaces are pasted with Bordeaux paste.</p>
Within 1-2 days after pruning	Spray vineyard with 1 % Bordeaux mixture within 1-2 days of pruning.
(During April – May or 15 to 50 days of back pruning)	<p>Anthracnose</p> <p>Spray Carbendazim 50 WP, 1.0 g / L (1Kg / ha) at emergence of bud or immediately after rains for control of anthracnose.</p> <p>Add 25 to 30 g citric acid per 100 L of spray water before adding above fungicides to ensure that the pH of the spraying liquid is in acidic range.</p> <p>Spray Ziram 27 SL, 4.0 ml / L or Chloronhalonil 2.0 g / L or COC 3.0 g / L or Copper hydroxide 77WP 2.0 g / L, 7 -10 days after the spray of systemic fungicide. Spray of such non-systemic fungicide is needed</p>

Days after pruning or growth stage	Control measure for disease
	<p>when it rains after first spray.</p> <p>If any anthracnose infected new shoot is noticed, manually remove the shoot.</p>
	<p>Powdery mildew</p> <p>Spray Sulphur 80 WDG 2.0 g / L Or Potassium bi-carbonate 10.0 g / L</p> <p>Use of spreaders (Silwet or Sure-shot) 0.1 to 0.2 ml / L will improve the efficacy of above mentioned non-systemic compounds</p> <p>Ziram 27 SL 4.0 ml / L can be mixed with Sulphur if anthracnose is present along with powdery mildew.</p>
<p>After the onset of the monsoon (During June and July)</p>	<p>Anthracnose / Bacterial leaf spot or stem canker / Downy mildew</p> <p>Maintain about 12 leaves from the base.</p> <p>Spray copper fungicides COC 50WP, 3.0 g / L., or Copper hydroxide 77WP, 1.5 g /L or 0.5 % Bordeaux mixture to control all or any one of the three diseases.</p> <p>Alternatively spray of any non-systemic fungicide recommended for control of both downy mildew and anthracnose in Annexure I eg. ziram, mancozeb, captan, chlorenthalonil etc.</p> <p>Repeat after 10-15 days interval, during breaks in rain. By the end of July, if 2 to 3 sprays of copper fungicides are given depending up on rainfall pattern, outbreak of downy mildew or anthracnose is effectively controlled.</p> <p>In late pruned vineyards, where shoot growth up to first 10 to 12 leaves is still continuing, spray Carbendazim 50WP, 1.0 g/L alone or in combination with COC 50WP 2.5 to 3.0 g / L to control only anthracnose.</p>
	<p>Powdery mildew</p> <p>Spray Sulphur 80WDG, 2.0 g / L Or Dinocap 48EC, 0.25 to 0.30 ml / L Or Potassium bi carbonate 10 g/L .</p> <p>Use spreaders (Silwet or Sure-shot) 0.1 to 0.2 ml / L for better efficiency of above fungicides</p> <p>Do not spray Dinocap if tender shoots are present in canopy.</p> <p>At the end of July especially after the onset of monsoon downy mildew and powdery mildew can be present together in vineyards. In such situations mixture of Sulphur 80WDG, 2.0 g / L and 0.5 % Bordeaux mixture can be sprayed. The pH of the Bordeaux mixture should be adjusted after the mixing of sulphur.</p> <p>In case of potassium deficiency, spray of mono-potassium sulphate (0:52:34 grade of soluble fertilizers), or Sulphate of potash (SOP) 2-3 g / L could give considerable reduction in powdery mildew incidence.</p> <p>IN continuously cloudy climate spray any systemic fungicide belonging to triazole groups (eg. Hexaconazole, penconazole, flusilazole, myclobutanil, tetraconazole etc.) at regular recommended dose (Annexure-I) along-with potassium bicarbonate 5.0 g/L.</p>

Days after pruning or growth stage	Control measure for disease
August to October	<p>Downy mildew, Anthracnose, Rust & Powdery Mildew.</p> <p>Rub off new sprouts emerging after rains.</p> <p>Prefer spraying non-systemic fungicides (Bordeaux Mixture, Copper hydroxide, COC etc.) for the control of downy mildew, rust and anthracnose if disease is present on old leaves.</p> <p>Spray Sulphur 2 g/L. plus Bordeaux mixture 0.5% if both downy mildew and powdery mildew infection is present</p> <p>Use of copper fungicides mentioned above should control rust disease also. In case if the disease is found to increase, spray systemic fungicides such as, Flusilazole 40EC 0.025 ml / L.</p> <p>Spray formulations of <i>Trichoderma</i> (<i>Trichoderma harzianum</i> / <i>T. viridi</i>) 2 to 5 g / L. One or two sprays at 10 days interval may be given when high humidity prevails.</p> <p>There should be gap of at-least 20 days between spray of fungicide and bio-control agent.</p> <p>Spray formulations of <i>Basillus subtilis</i>, 1.0 ml/L for the control of powdery mildew</p> <p>Spray mineral oil formulation such as HP grape spray oil 5.0 to 10 ml/L. Such spray oils are not compatible with Sulphur and copper fungicides, and captan. Hence ensure that at-least 20 days have passed after the spray of such fungicides, before the spray of mineral oil formulations.</p>

After fruit pruning (October to March)

Days after pruning or growth stage	Control measure for disease
Immediately after pruning	<p>Clean cultivation</p> <p>All diseased vine parts, dead woods, removed barks, pruned remaining of vine and weeds should be removed</p> <p>Spray 1 % Bordeaux Mixture within 1-2 days of pruning on canes and arms to kill left over disease inoculums.</p> <p>Mix mancozeb 75 WP, 5 to 7 g/L with Hydrogen cyanamide solution for swabbing canes. This will help in killing pathogen inoculums (of downy mildew and anthracnose) if present on canes. If mancozeb is mixed with hydrogen cyanamide, use of red colour can be avoided as yellowish colour of mancozeb will help identifying treated cane in vineyard.</p> <p>If the un-pruned block is in close vicinity of pruned block, and the pruning in that block is not likely to take place within 5-8 days, it will be essential to spray 0.5 % bordeaux mixture in un-pruned block to avoid movement of inoculums from unpruned block to young shoots in pruned block. Sporangia of downy mildew can travel through air up to 100 m distance, while conidia of powdery mildew can be disseminated through air up to long distances.</p> <p>While staggering pruning in vineyards direction of air also should be</p>

Days after pruning or growth stage	Control measure for disease
	taken in to consideration. Normally during October wind direction is East to west, hence early pruned blocks in the vineyard should be preferably in the eastern side so that there will be the least possibility of movement of airborne inoculums from unpruned blocks to new shoots in pruned block.
8 days after forward pruning	<p>Anthraco­nose, and <i>Xanthomonas</i></p> <p>Spray systemic fungicides such as Carbendazim 1.0 g / L or difenconazole 25EC, 0.5 g/L, followed by non-systemic fungicides COC 3 g / L or copper hydroxide 77WP, 1.25 g/L after 2-3 days. Sprays of copper based fungicides can restrict the infection of bacterium <i>Xanthomonas</i>, and are useful in avoiding development of resistance in anthracnose pathogen against systemic fungicides.</p>
10 days onwards	<p>Downy mildew</p> <p>Sprays for downy mildew control are needed when new shoots remain wet due to dew up to 8 to 9 am in the morning or it rains during the day.</p> <p>Sprays of systemic fungicides are needed at every three days interval after 10 days of pruning. However, in the absence of rainy condition, and if morning dew is not very heavy, spray interval can be extended up to 5 days. One additional spray of non-systemic fungicides can be given between two systemic fungicides to reduce the risk of the disease.</p> <p>List of recommended systemic and non-systemic fungicides is given in Annexure The list is updated every year during October and is available on website of NRC for Grapes (http://nrcgrapes.nic.in)</p> <p>Spray anyone of the systemic fungicides from the list at 3 leaf stage, 5 leaf stage or 7 leaf stage as mandatory sprays, while maintaining spray interval at 5 days.</p> <p>Avoid using fungicides such as azoxystrobin, kresoxim methyl during first 18 to 20 days growth after forward pruning.</p> <p>Spray for downy mildew should be preventive and should be given before the start of rainy days or after the rainy days are over.</p> <p>If the rainy days are extended beyond 3 days, or when spray before the start of rainy days could not be given, or presence of downy mildew symptoms is observed in the vineyard or adjacent vineyard, spray non-systemic fungicides available as wettable powders (WP) can be applied as dusting.</p>
25 to 35 days	<p>Downy mildew and anthracnose</p> <p>Mix Fosetyl Al 3 g / L in solution of GA prepared for spray. Normally 2 to 3 sprays of GA are given. Only one of these sprays, preferably first or second, spray may be given along with Fosetyl Al. Time of spray may be decided considering, the time of spray of systemic fungicide for downy mildew given before the start of GA sprays. pH of spray solution of fosetyl al is acidic and hence helps better absorption of GA.</p> <p>However, if wet weather prevails during GA applications, spray of non-</p>

Days after pruning or growth stage	Control measure for disease
	systemic fungicides other than copper fungicides is given after spray of fosetyl al and /or subsiquant spray of systemic fungicide is given at 3 days interval instead of 5 days.
	<p>Powdery mildew</p> <p>If cloudy climate prevails there will be increase in morning temperature and morning dew may remain for less time. Under such situation powdery mildew can develop sporadically in vineyards leading to development of inoculum.</p> <p>Spray Sulphur 80WDG 2.0 g / L. Avoid spraying sulphur after fruit set.</p> <p>If the cloudy climate persists for long period one spray of systemic fungicides recommended for powdery mildew (Annexure I) may be needed. Fungicide such as flusilazole has long PHI and is not recommended after fruit set due to residue problems can be preferred during this period.</p>
35 to 50 days	<p>Downy mildew</p> <p>It is most deceptive period, as even if there is no much dew in the morning hours, downy mildew may appear only on bunches, and cause flower drop, or complete destruction of bunch. Infection on leaves under such situation may be nil or minimum. About two preventive sprays of systemic fungicides for the control of downy mildew, at 5 days interval are essentially needed during this period.</p> <p>Powdery mildew</p> <p>Cloudy conditions will start the development of powdery mildew during this period. As most growers are more worried about downy mildew infection during this period, light infections of powdery mildew could be un-noticed. The worldwide it is observed that if powdery mildew infection is developed on bunches during flowering to fruit-set period, it becomes very difficult to control the disease on bunches during later stages. Especially it could lead to rachis infection of powdery mildew after veraison stage. Therefore at least one spray of systemic fungicide for the control of powdery mildew is needed during flowering stage.</p> <p>It is an ideal time for sprays of strabularin fungicides such as azoxystrobin 23SC or Kresoxim methyl 44.3 SC, as it will provide protection against both downy mildew and powdery mildew.</p>
50 days onwards	<p>Powdery mildew</p> <p>Ensure that vines do not suffer from potassium deficiency. In case deficiency is observed give sprays of potassium nitrates / Potassium sulphate / Monopotassium phosphate, are suggested. Follow the guidelines given under Nutrition.</p> <p>Spray any one of the recommended systemic fungicides at 7 to 10 days interval starting immediately after fruit set i.e. about 50 days of pruning. Spray interval can be decided on the basis of weather conditions or actual presence or absence of disease in vineyards.</p> <p>Whenever powdery mildew infection is seen in vineyard spray of tank</p>

Days after pruning or growth stage	Control measure for disease
	<p>mix of regular dose of systemic fungicide and Potassium bi carbonate 5 kg / ha is useful to eradicate left over powdery infections.</p> <p>Between two sprays of systemic fungicides non-systemic fungicide Dinocap 48EC, 25 ml/100 lit water can be sprayed up to 65-70 days after pruning.</p> <p>Most of the fungicides for the control of powdery mildew are given after fruit set. To avoid the residue of these fungicides in berries at harvest, recommended pre harvest intervals (PHI) and maximum residue levels (MRL) should be considered while selecting fungicide for spray at different growth stages. Normally, fungicides with long PHI and low MRL are selected for spray at early fruit growth stages. Use of flusilazole should be avoided after fruit set, while fungicides such as penconazole, and tridemefon should be selected up to first 80 days of pruning and hexaconazole or myclobutanil should be preferred close to veraison stage.</p>
75 to 90 days	<p>Powdery mildew on bunches or rachis</p> <p>Spray of strabularin fungicides such as azoxystrobin, which has PHI as low as 7 days, and MRL as high as 2.0 ppm. Hence such fungicide can be used for control of powdery mildew on bunches during last 30 days of berry maturity.</p> <p>Spray of sulphur 80WDG, 1.0 to 1.5 g / L can be given during last 20 to 30 days of berry maturity for the control of powdery mildew. Such sprays can be given alongwith good quality spreaders (Silwet or Sure-shot 0.05 to 0.1 ml / L) to avoid stains on berries.</p> <p>If less than 30 days are left application of formulations of bacteria such as <i>Basillus subtilis</i>, <i>Pseudomonas fluorescense</i>, or mineral oils (HP Grape Spray oil 5 – 7 ml / L) or plant extract based formulations such as Sporekiller 2 to 4 ml /L or Tricure 4 to 5 ml / L can be used as spray on bunches for the control of powdery mildew without the risk of objectionable residue.</p> <p>Before application of any formulation few days before harvest it is advised to try the formulation first on few plants and if any spot or similar abnormality is not seen on berries the formulation can be used for spraying entire vineyard.</p> <p>Post harvest diseases</p> <p><i>Trichoderma</i> sprays reduce post harvest rots of berries and increase shelf life depending up on quality of grapes.</p> <p>Pre harvest Spray treatment of <i>Trichoderma</i> spp. May be given Two sprays within the span of 15 days at weekly interval may be given using liquid formulations @ 5 ml / L.</p> <p>In the event of rains during pre-harvest period application of <i>Trichoderma</i> can be preponed.</p>

Chapter 8

Insect and mite pest management in wine grapes



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Among various insect and mite pests attacking wine grapes, mealybugs, leafhoppers, red spider mites, thrips, and stem borer cause significant damage in terms of both quantity and quality of wine grapes. In addition, flea beetle, chafer beetles and caterpillars are also occasional pests. In this chapter, identification, biology and management guidelines are discussed for these pests for production of quality wine grapes. The pre-harvest interval (PHI) of different insecticides is followed same as table grapes in this chapter.

Mealybug

The mealybug species infesting wine grapes have been identified as pink mealybug, *Maconellicoccus hirsutus* Green (Figure 1) and *Planococcus* spp.

Biology

Adult female mealybug is small, pinkish (*M. hirsutus*) or yellowish white (*P. citri*) with the body covered with a waxy secretion. Egg appears orangish-red in colour laid in groups of 350-500 in terminal ovisacs. Eggs hatch in a period of 7 days. The first instar nymphs referred as 'crawlers' are highly mobile, easily carried off by wind. They move and settle over the plant parts to initiate the feeding action. Female passes through three nymphal instars and male has four nymphal instars. The third instar nymph of male forms a cottony white cocoon inside which the pupation

occurs. All the nymphal stage of the female looks similar except for the difference in size. The total nymphal



Fig.1. Pink mealybug

period is 21 days for male and 19 days for female mealybugs. Male mealybugs are rare and female occurs throughout the year. They are capable of reproducing parthenogenetically and completes lifecycle within 30 days under favourable conditions.

Nature of damage

Among different insect pests causing damage in wine grapes, mealybugs are most difficult to manage as they have protective mealy covering on their body and form colonies in protected areas like cracks & crevices. Both nymphs and adults cause damage by sucking sap from stem, cordons, buds, aerial roots, shoots, flower panicles and bunches. Mealybug infestation on bunches reduces sugar content in juice which in turn reduces wine quality. When feeding on stem, they remain concealed below loose bark, thus gets

hardly exposed to chemical sprays. Feeding by mealybugs can be severe enough to stunt vine growth. In addition to their feeding damage, mealybugs had been reported to act as vector of leaf roll virus. Therefore, effective management of mealybugs is essential for wine grapes.

Management

1. Weed plants act as alternate host plants for mealybugs therefore proper weed management is necessary.
2. After fruit pruning, mealybug infestation always starts in scattered patches during December to January. Regular monitoring of vineyards is necessary to know the start of mealybug infestation. If less than 10 per cent plants are affected before flowering stage, then spot application with methomyl 40 SP at the rate of 1.0 gram per liter of water using knapsack sprayer is effective. Tag mealybug infested plants with red ribbon so as to recognize easily while spraying. The infested plants along with neighbouring plants should be covered during spot application. To ensure better coverage, loose bark of stem should be removed before spraying and spray should be targeted towards stem, cordons & shoots. If more than 10 per cent plants are found infested then whole vineyard may be sprayed. However, care should be taken that methomyl 40 SP should not be sprayed after flowering stage and only single application of this chemical is recommended
3. During months of February, March and April, mealybug development attains faster pace due to high temperature and abundant availability of food material. Once

sugar development starts in berries, mealybug management becomes very difficult. Therefore, the rule for mealybug management in wine grapes is to keep its population in control before sugar development in berries. If mealybug infestation occurs, buprofezin 25 SC at the rate of 1.25 ml per litre of water can be sprayed while maintaining the pre harvest interval of 40 days. Not more than two applications of this chemical should be done in a season.

Thrips

The major thrips species infesting wine grapes was identified as *Scirtothrips dorsalis* Hood (Figure 2).



Fig. 2. *Scirtothrips dorsalis*

Biology

Adults are very small in size measuring about 2 mm in size and very agile in behaviour. The adults have four narrow fringed wings. The female thrips inserts eggs in the tissues on the underside of the leaves near midrib. Nymphs hatch out from the eggs in about 5-7 days and feed on the young leaves, flowers or developing berries. The mature nymphs move down to the soil and pupate in the top soil. The life cycle of the pest is completed in about two weeks. Thrips population is observed throughout the year. However, its infestation is more during

10-50 days after pruning on the new shoots. The peak population can be observed during early shoot growth, flowering and berry setting stage of the crop. Rainfall reduces the thrips population.

Nature of damage

Both nymphs and adults are damaging stages of the pest. Thrips have only left mandible present in their mouth parts. With the help of the mandible, the lower surface of the leaf is rasped and the oozing cell sap is sucked. This injury gives a speckled silvery effect to the leaves. Thrips



Fig.3. Berry scarring due to thrips on Cabernet Sauvignon

feeding is mainly found on the new growth of shoots and cause shoot stunting and curling of the leaves. The thrips also cause damage to the blossoms and developing berries. At flowering stage, thrips infestation reduces fruit setting and thereby yield is reduced significantly. During berry development stage, the thrips cause injury to the berry surface which later on enlarges with the berry growth and appear as berry scarring (Figure 4).

Management

1. Regular monitoring is necessary to detect early infestations, so that timely control measures can be initiated. Randomly observe 20 grapevines on daily basis representing one acre vineyard. Tap young shoots, flowers or bunches on A4 size white paper and count. If 2 thrips per shoot are observed then curative management interventions are required.
2. The vineyards should be kept clean from weeds throughout the year to eliminate the source of infestation.
3. Summer deep ploughing and frequent harrowing in between rows help in destroying pupal stage of the thrips and minimizing the incidence.
4. Chemical Control: New flush, flowering and berry developing are high risk stages of the crop therefore the vineyards should be monitored during these stages. Pre harvest interval (PHI) should always be followed while applying insecticides.

Table 1. List of insecticides effective to manage thrips

Insecticide	Dose	PHI (Days)
Imidacloprid 17.8 SL	0.30 mL/L	60
Lambda-cyhalothrin CS	0.50 ml/L.	30
Emamectin benzoate 05 SG	0.22 g/ml/L	25
Fipronil 80 WG	0.05 g/L	60

Leafhoppers

The jassid species causing damage to grapes was identified as

Amrasca biguttula biguttula Ishida



Fig.4. *Amrasca biguttula biguttula*

(Figure 4).

Biology

The adult jassid is a small, wedge-shaped insect, measuring about 3.5 mm in length and is yellowish green in colour with black markings on the vertex and forewings. Adults are active insects with characteristic sidewise movement but quick to hop and fly when disturbed. Eggs were thrust into the epidermal tissue of the leaves. Eggs hatch in about 7-14 days. Nymphs pass through five nymphal instars lasting for 7-21 days and total life cycle is completed in about 20-30 days depending upon weather conditions. These insects can complete more than 10 generations in a year. The image of adult stage of this pest is given here for identification for farmers and extension workers. The adult lives for about a month. With decrease in minimum temperature during October-December months, the nymphal population of jassids goes down and adults continue to feed on grape leaves.

Nature of Damage:

These are the sucking pests which prefer to feed on the succulent and juicy tender parts of the vine like young leaves on the shoot. Immediately after the September-

October pruning (fruit pruning), the peak population of jassids coincides with the emergence of new flushes and inflorescence. Both nymphs and adults suck the plant juice, which result in the distortion of the leaf lamina mainly the downward and irregular curling symptom.

This distortion of leaf lamina helps the insect to hide as well as provide suitable microclimate for their further multiplication in addition to the reduction of effective photosynthetic area of the vine and thereby reducing the yield. Later on, these curled leaves may also develop powdery mildew. Leaf injury may reduce vine growth and interfere with berry ripening.

Berries on leafhopper damaged plants also have a delayed berry sugar accumulation with lower sugar and increased acid content thereby affecting the quality of the wine produced from these grapes.

Leafhoppers which are also called as jassids were so far considered as minor insect pest of grapes. Recently, this pest was found causing significant damage in grapes which can be attributed to the favourable weather conditions for its multiplication. The vineyards with high weed incidence are most affected. The most susceptible crop stage for leafhopper incidence is from bud sprouting to berry setting. Once the leaves become mature and shoot growth is stopped, the leafhopper population declines naturally. Further, October and November months experience the maximum leafhopper incidences if crop stage is favourable.

Management

1. Judicious use of nitrogenous fertilizers as high nitrogen application increases succulence in the leaves which favours multiplication of this pest.

Application of potassium provides resistance to grape plants against jassids.

2. Many weeds mainly graminaceous plants are alternate hosts for this pest and therefore should be removed from the vicinity of vines in the farm.
3. Installation of yellow sticky traps at the rate of 125 per hectare and light traps with compact fluorescent lamp (CFL), halogen or Mercury Vapour lamp attracts the jassids and help in reducing their population.
4. Among chemical methods, Imidacloprid 17.8 SL @ 0.30 ml per litre water (pre harvest interval of 60 days) or Buprofezin 25 SC @ 1.25 ml per litre of water (pre harvest interval of 40 days) or Fipronil 80 WG @ 0.05 g per litre of water (pre harvest interval of 60 days) or Lambda cyhalothrin 5 CS @ 0.5 ml per liter water (PHI of 30 days) is also helpful in managing this pest. The insecticide applications should be made during evening hours. Installing halogen light at the back of tractor while spraying in night, gives better results with contact insecticides. Avoid spraying during bright sunlight hours.

Mites

The red spider mite infesting grapes in peninsular India has been identified as *Tetranychus urticae* Koch. (Figure 5).

Biology

The pest is usually active from December to March-April. In those gardens where the foundation pruning has undertaken early by the month of January or February, the pest will be a problem in the new shoots also in spite

of its preference to feed the older leaves.

Mites are very small, 0.1-0.5 mm size



Fig.5. *Tetranychus urticae*

and resemble the spider lings. The lifecycle of mites pass through egg, larvae, protonymph and deutonymph and adult stages. Each nymphal stage contain a quiescent non-feeding resting stage between each nymphal instar. The adult mites are pale yellow or sometimes red bodied with two spots on the dorsal side and are actively moving once disturbed. Adult spider mite females are reddish. Their pointed abdomens and smaller size easily recognize males. Adult mites live for about 15 days.

Egg appears spherical, translucent whites in colour laid usually on the under surface of the leaves close to the midrib inside the webbings made by the mite. Hatching occurs within 3-6 days. The egg hatches into six-legged larvae. Protonymph and deutonymphal stage of mite lasts for 7-8 days and they possess eight legs. Lifecycle was completed within 15 days under favourable conditions. Freshly emerged adult females are 0.5 mm long and devoid of spots but as the feeding begins, the spots become more distinct. Usually two large, diffuse spots appear forward.

If the population is more, they are found inside the webbings which resemble that of a spider. The webbings along with all stages can be

seen on the underside of the leaves especially with the help of a hand lens (20-40x).

Red spider mites should be considered as induced pests of grapes, their population gets increased following the use of broad spectrum insecticides for the control of pests is known to make the mites to emerge as one of the important sucking pests of wine grapes. The population build up of mites also depends on the climatic conditions like in the case of many insect pests.

Nature of damage

Both the adults and young ones suck the sap of the leaves which leads to pale yellow tinge on the upper side of the leaves. Under severe infestation, the leaves further turns from yellow to brownish tinge with slight downward cupping harbouring colonies of mites with webbings on the underside of leaves. High populations may cause leaf burning, which can decrease photosynthesis and accumulation of vine energy reserves. This also leads to defoliation and thereby affecting the vigour and vitality of the plant. The unmanaged population acts as a cause for population build up for the next season as well as to the neighbouring vineyards as it can be easily carried by wind. Mites also infest the sepals and young fruits during the fruiting season in the case of severe infestation, which leads to reduction in TSS and fruit quality. Heavier mite population may delay the ripening of the berries.

Management

1. Mite population can be monitored by the close examination of older leaves in 4-5 shoots from randomly selected 20 plants in a vineyard. If 5 mites per shoots per plant are seen, control measures need to be undertaken.

2. Avoid using broad spectrum chemicals in the flushing stage of crop after the fruit pruning as this causes the resurgence of pests like mites at the later stage of the crop.
3. Keep the vineyards weed free as weed plants can act as source of inoculum for mites.
4. The receipt of heavy rainfall can wash out these small insects like thrips, mites etc. During heavy rainfall periods, there is no need to undertake any chemical spray.
5. Growers should take consideration of label registration with CIBRC, PHIs and MRLs while making spray decisions. Sulphur 80 WDG @ 1.5 -2.0 g/L (PHI 7 days) water can be used where mite infestation is noticed.
6. Water stressed plants and plants which are near roads (due to dust) get higher mite incidence. Maintenance of permanent ground covers instead of bare soils in the vineyards may decrease air temperature and raise humidity levels thereby providing suitable microclimate that discourage the build up of mite population.
7. Proper irrigation and 1000 liter per acre water spray in morning hours at weekly interval helps in reducing mite infestation to some extent.
8. For the management of mealybugs, Buprofezin 25 SC @ 1.25 ml/L water is recommended. This chemical, in addition to provide control of mealybugs, is also effective in reducing mite population.

Stem Borer

Stem borer has recently attained the status of major pest of grapevine in India. *Stromatium*

barbatum (Figure 6) is the major species infesting grapevine.



Biology

The adult beetles start emerging out after first good monsoon rainfall and lay eggs on the bark of stem, cordons and branches. The adult emergence and egg laying continue up to September month. Female beetle makes conspicuous slit on the bark of the trunk and branches, and lays 12-15 eggs in the slits singly covered with a hard gummy like substance. Eggs are similar to rice grain in shape and white in colour. Eggs hatch in about 10 days. The newly hatched flat-headed cream coloured apodous larvae having powerful mandibles enter directly inside the trunk and arms and start feeding. The larval period lasts for 6-8 months. The full grown larva measuring 75 mm in length pupates in the tunnel within a calcareous cocoon. Pupal period lasts for 25-35 days. Adult beetles measuring 40 mm in size, are stout and dull yellowish in colour with minute spots.

Adults live for 20-25 days. The whole life cycle is completed in about 10-11 months.

Nature of damage

These are the group of pests which can kill the whole vine compared to other pests in grapes. Adult emergence coincides with the onset of monsoon during May-June. Soon after mating, the females lay the eggs in the crevices of bark. After hatching, the grubs bore into the vine and the remaining part of their life cycle is completed inside the vine. In the later stage of infestation, bore holes and leaves with interveinal chlorosis can be observed. More than one borer can infest single vine and parts like trunk, cordons and also branches having more than 1.5-2 cm diameter are preferred. Bored holes, heaps of excreta (either in pellet or in powder form) in and around the plants, general weakness of the plant, chlorotic leaves etc. are the symptoms of stem borer infestation in vineyards. Severe infestation leads to vine death.

Management

1. As the adults are attracted to light, installation of Fine Light Trap @ 1 trap per hectare helps to trap and kill the adults especially soon after rain. The traps should be installed atleast 15 feet away from vineyard at three feet above ground level.
2. At the time of adult emergence methomyl 40 SP @ 1.0 g/L water or lambda cyhalothrin 5 CS @ 0.5 ml/L water can be sprayed at fortnight interval.
3. During fruiting season, if stem borer infestation is noticed then hooking and removing the grub with iron wire can be done.

Chapter 9

Maturity and harvesting of wine grapes



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Dr. A.K. Sharma
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The quality of the wine is influenced by the quality of the grapes and various factors such as, weather (precipitation, temperature and sunlight), training system, canopy development, crop load, water management, incidence of insect pests and disease and timing of harvest. Time of harvest is the most important and challenging viticultural decision for the grape growers due to the difficulty in assessing grape maturity in the vineyard and predicting wine quality. Moreover, demand from winery as well as intervene by winemaker considered to decide harvesting.

1. Maturity:

The quality of wine is decided by grapes from which wine is made. There are many aspects of grape maturity that determine the best time to harvest the wine grapes. Some of these are quantitative and others are qualitative and are more subjective. Qualitative indicators of grape maturity include appearance of the grapes including the colour and firmness of the skins, the appearance of the stems, the colour and taste of the seeds and grape juice and pulp.

1.1 Qualitative evaluations:

Berries - Berries dehydrate slightly, and the texture of the pulp softens when grapes ripen. When red grapes are fully ripe, the berries feel lesser firm when squeezed and the skin

becomes slightly slack but not wrinkled like a raisin.

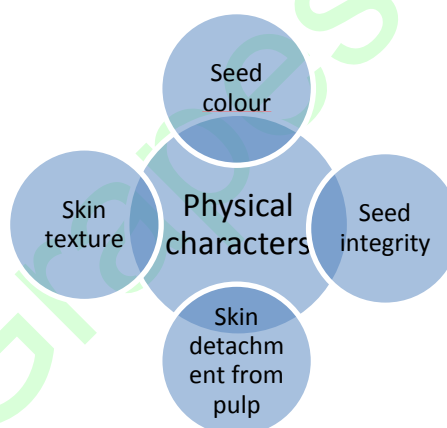


Fig. 1. Physical characters considered for maturity of berries

Flavors - Under-ripe red grapes often have a green, herbaceous smell and taste reminiscent of asparagus or bell peppers. Ripe grapes have less of this green, herbaceous character and more plum and cherry fruit characteristics.

Seeds - The colour of grape seeds changes from green to brown as



the berries ripen. In most varieties, the pointed ends of the seeds (the “beaks”) are the last part to turn brown. About 80 – 90 % of the seeds should be brown before harvest.

Pedicle - When grapes are fully ripe, the pedicle (stem) can be pulled off the berry easily and little or no pulp or skin tissue should be attached with the pedicle of grape berry.

1.2 Quantitative evaluations:

To determine the maturity of wine grapes, quantitative parameters like total soluble solids (in °Brix), pH and acidity play important role. Out of these parameters TSS is most important. Sugar content in berries not only decides maturity, but also give the liberty to winemaker to produce wines with various styles like very sweet, sweet or dry having desired level of alcohol. The more TSS content of berries results in sweeter taste. In addition to the measurement of TSS, the analysis of pH, and titratable acidity (TA) are also play an important role in deciding level of maturity. In general, the ranges of these quantitative parameters as TSS: 22 - 25 °B; Titratable acidity 0.58 - 0.65 per cent; pH 3.4 – 3.6 considered very suitable for production of quality wines. Index measured in form of $\text{sugar} \times \text{pH}^2$ found better indicator of assessing optimum ripeness. According to this measurement, the best wines are made at index values ranging from 200 to 270.

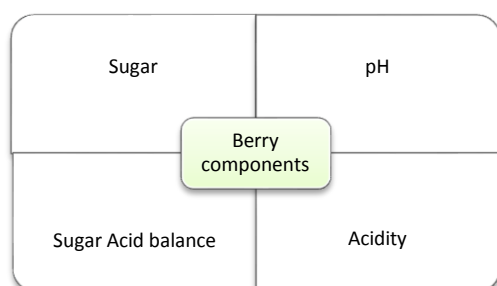


Fig. 3. Basis for assessment of berry maturity

1.3 Berry Sensory Assessment (BSA):

Berry Sensory Assessment (BSA) is a technique that is very useful to grape growers and winemakers when decisions need to be made on harvest date. BSA may be carried out at pre-harvest choosing 6 bunches and assessing them based on defined criteria for skin, seed and pulp maturity. BSA is performed in the vineyard and helps to assess the flavour and tannin ripeness and provides a language to express these important criteria. Ripeness is really defined by the individual, whether grape grower or winemaker, and it is primarily a function of the intended use for the grapes. Assessors require a basic knowledge of taste and fruit aroma physiology and need to be familiar with and be able to identify tastes, such as bitterness, astringency, acidity and sweetness, and mouth feel of attributes like body, juice/pulp thin or thick.

2. Harvesting:

The date for harvesting of wine grapes is affected by several factors like variety, maturity (mainly TSS), appearance of berries, availability of skilled labours, size of the crop, requirement of winery etc. Harvesting of wine grapes is decided as per requirement of winemaker and winery. However, proper maturity is a must otherwise it will result into young, immature grapes yield wines with less depth, richness and flavour in both red and whites. A healthy grape harvest can ensure optimal quality and safety of vitivinicultural products. The hand picking is only method for harvesting of wine grapes. The pickers should be advised to pick only healthy grape bunches. The collection of bunches having damaged berries are always avoided. Damaged berries not only affect wine quality, but also it is more



Fig. 4. Appearance of Cabernet Sauvignon bunch at the time of harvesting



Fig. 5. Uneven matured bunch

important to make safety wines. When grapes extensively damaged by moulds, it is advised not to be used for making concentrated musts, grape juice, wine or vinegar. The grapes damaged by insects, mould, or contaminated by dirt particles must be eliminated before the harvest or at the time of harvest.

2.1 Hand picking:

Manual harvesting is slower and labour intensive. It does however, allow for a great deal of selection of the grapes; unripe or rotten grapes can be left on the vine or discarded.

Less damage occurs to the grapes as bunches are harvested whole; a huge benefit because oxidation begins once the grape has been punctured. Undesirable bunches containing berries having much variation in colour and size should not be picked (Fig.). Hand harvesters also use smaller containers to transfer the grapes which helps in reducing the

damage to the grapes during harvest. The grapes contaminated extensively by mould or insects should not be picked for winemaking. The healthy bunches fulfilling requirements of winemaker or winery should only be picked. Availability of skilled worker during harvesting period is only limiting factor.

2.2 Harvesting time:

Usually harvesting of wine grapes starts from end of December to end of February depending upon pruning time. In our conditions temperature goes very high during day hours. High temperature leads to decrease in grape quality, increases the microbiological load and chances of unwanted fermentation from vineyards itself. All these factors negatively affect the wine quality. For making good wines from hot areas, it is always advised to harvest wine grapes at minimum temperature. It is better to harvest the grapes during night hours, if not possible during nights, harvesting in the early morning hours

only option for producing optimum quality wines. Hand harvested bunches can be carefully collected and placed gently in containers to minimize breakage. Receiving of undamaged berries in cool condition, significantly minimize unwanted oxidation and potential growth of undesirable

microorganisms on the berries or released juice. Always use clean containers not having particles of rotten berries. Harvested grapes must be transported as quickly as possible to the winery in order to avoid extended waiting during transit and also in winery.

NRC for Grapes

Chapter 10

Agrochemical Residue Management in Wine Grapes



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Introduction:

Grape is one of the most important horticultural crops of our country. In India, most of the grape growing areas are covered under table grapes and located in peninsular region characterized by sub-tropical climate. Although the area under wine grapes is very small, it is increasing very drastically and India is in a stage to export wines. Currently, the country's wine exports are about Rs 25 crore and the vineyards are increasing in the country and simultaneously the production is growing. Indian wine industry is in a nascent stage but is expected to grow multi-fold. The quality of the grape is more vital in producing good quality wine. The greatest obstacle in producing grapes of international quality standard is the frequent attacks of various insect pests and diseases. Since grape is highly susceptible to a number of insect pests and fungal diseases, the production of good quality grape largely depends upon the prevalent pest management practices. In spite of having several options of pest management like biological control, physical control, cultural control, etc., the use of pesticides is almost inevitable for effective management of grape pests and diseases. Usually a grape grower, on an average, gives around 40-45 sprays of pesticides in a crop season to control a variety of insect pests and fungal diseases. The other important fact is that the growers are using plant

growth regulators to fulfill the quality requirements of the consumers. As a result, there is likely accumulation of their residues in grape berries at toxic level at the time of harvest and ultimately it reaches to the wine after the processing. As per the Food Safety and Standard Authority of India Act, 2006, sale of any food commodity containing pesticides residues above the prescribed maximum residue limits (MRL) is prohibited. Such contaminated food is branded as 'substandard food commodity' for sale in both local as well as export markets.

Indian wines are also exported to various destinations in Asia and Europe. But, it is under constant scrutiny of the environment and health protection agencies worldwide, due to the reasons stated above. As wine is acidic and kept under refrigerated condition till its consumption, the chances of degrading the agrochemical residues in wine is very less. Detection of the residues above MRL may lead to rejection of the export consignment. Identification of such contaminated consignments may bring serious setback to our grape and wine industry as a whole. Residue level of agrochemicals may remain above the MRL in/on a food commodity due to either deliberate misuse at field in terms of dose and time of application or accidental contamination. Thus, management of agrochemical residues in wine grapes at field level is a challenge to the scientists as well as to

the other stakeholders of the grape industry since the consumers have no choice left besides exposing themselves to the residues when it is present in wine.

Sources of Agrochemical Residues in wine:

The only source through which agrochemical residue can reach to wine is through the grape used for wine making. The sources of agrochemical residues in grape are given below.

Direct Source: Agrochemicals are directly used for pest management in grapes. They are basically organic or inorganic compounds which degrade with time to non toxic metabolites on exposure to physico-chemical e.g. sunlight, heat, humidity, chemical agents in atmosphere, etc., and biological factors viz. enzymes,

microbes, etc. When these are applied directly on the plants, a fraction of it gets adsorbed on the surface or absorbed inside the fruits. The time required for degradation of a toxic molecule to harmless metabolites may vary from hours to years depending on the chemical nature of the compound and its susceptibility to the degrading factors (Figure 1). If a crop is harvested before such period and used for wine making, then analysis of the samples results in detection of the residues and consumption of such contaminated food may result in acute toxicity.

Indirect source: Spray drift from adjoining crop fields, contaminated soil and irrigation water, contaminated agro-inputs like manures, fertilizers etc. can also be source of pesticide residue.

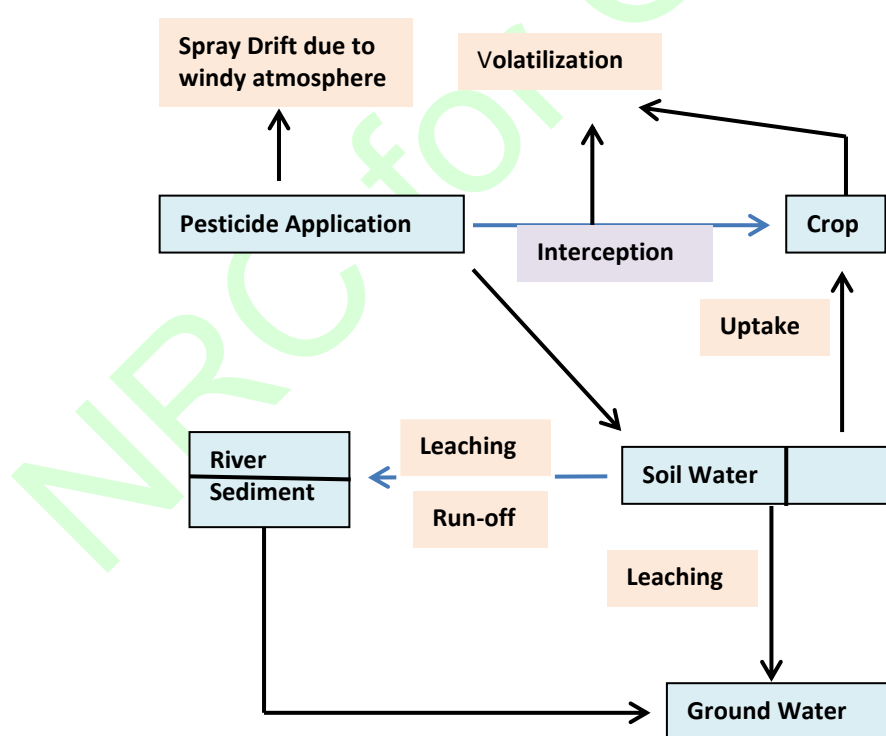


Figure 1: Sources and fate of pesticide residues in wine yard

MRL and its relationship with the GAP

MRL is the legally permitted concentration of the residues of pesticides 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 subpopulation 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 MRL. The Codex Committee on pesticide residues (CCPR) was formed by United Nations with primary mandate to establish MRL for pesticides in food. In India, the MRL of pesticide are prescribed under the Food Safety and Standard Authority Act, 2006. MRL of pesticides are usually crop or food item specific.

Although the Codex MRLs are applicable to all the nations, individual countries may 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 country. There is separate MRLs for table grapes and wine grapes for the importing countries. 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.

Terminal residue load of an agrochemical in wine grape or any

other commodity 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 degrading factors like period of sunshine and atmospheric temperature are more prominent under the tropical environment. The dissipation pattern in one crop may not be similar to another crop also. Keeping in view of this fact, supervised multi-location trials are usually conducted to establish the 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 (usually children; for EU, a body weight of 16 kg is considered). 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. 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 for 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.

Pre-harvest interval – the concept 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. Since there is

no separate PHI is available for wine grape, for the time being the PHI data generated for table grape can be adopted in wine grape also. The data generated on the PHI for different agrochemicals are given in Table 1. 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 the 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, usually, first + first order degradation kinetics governs the dissipation of most of the pesticides, where the residues dissipate with time following a non-linear relationship. The dissipation rate is faster at the beginning and gets slowed down with the 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 behavior of most of the pesticides and predict the PHI.

Table 1. PHI for different agrochemicals having label claim of CIB in grapes

Sr. No.	Chemical recommended for major disease & pest	Dose on formulation basis	Pre-harvest Interval (PHI in days)
I	Downy Mildew		
1	Mancozeb 75 WP	1.5-2.0 g/L	35 (avoid using after fruit set)
2	Propineb 70 WP	3.0 g/L	40 (avoid using after fruit set)
3	COC 50 WP	2.5 g/L, 2.4 g/L	42 (avoid using after fruit set)
4	Chlorothalonil 75 WP	2.0 g/L	60
5	Fosetyl Al 80 WP	1.4-2.0 g/L	7

Sr. No.	Chemical recommended for major disease & pest	Dose on formulation basis	Pre-harvest Interval (PHI in days)
6	Metalaxyl + Mancozeb 8+64 WP	2.5 g/L	66
6a.	Metalaxyl-M + Mancozeb 4+64 WP	2.5 g/L	66
7	Cymoxanil + Mancozeb 8+64 WP	2.0 g/L	66
8	Dimethomorph 50 WP + Mancozeb 75WP as tank mixture	0.5 to 0.75 g/L + 2.0 g/L	66
9	Fenamidone + Mancozeb 10+50 WG	2.5 to 3 g/L	66
10	Azoxystrobin 23 SC	494 mL/ha	7
11	Iprovalicarb + Propineb 5.5+61.25WP	2.25 g/L	55
12	Famoxadone 16.6 % + Cymoxanil 22.1 % SC	500 mL/ha	27
13	Kresoxim methyl 44.3 SC	600-700 mL/ha	30
14	Fenamidone 4.44% + Fosetyl-Al 66.66% WDG	2 to 2.5 kg/ha	27
15	Pyraclostrobin 5% + Metiram 55% 60WG	1.5-1.75 kg/ha	15
16	Mandipropamid 23.4% SC	0.8 mL/L	5
II Powdery Mildew			
17.	Penconazole 10 EC	0.50 mL/L	50
18.	Triadimefon 25 WP	0.50-1.0 g/L	45
19.	Hexaconazole 5EC	1.0 mL/L	60
20.	Myclobutanil 10 WP	0.40 g/L	30
21.	Flusilazole 40 EC	25 mL / 200 L	50
22.	Fenarimol 10 EC	0.40 mL / L	30
23.	Difenoconazole 25EC	0.50 mL / L	45
10a.	Azoxystrobin 23 SC	494 mL / ha	7
13a.	Kresoxim methyl 44.3 SC	600-700 mL/ha	30
24.	Dinocap 48 EC	0.30 - 0.35 mL/L	50 (avoid application when tender shoots are present in canopy)
25.	Sulfur 40 SC, 55.16 SC, 80 WP, 80 WDG, 85 WP	3.0 mL, 3.0 mL, 2.50 g, 1.87-2.50 g, 1.50-2.0 g/L, respectively	15
26.	Tetraconazole 3.8EW	0.75 mL/L	30
III Anthracnose			
2a	Propineb 70 WP	3.0 g/L	40
3a.	COC 50 WP	2.5 g/L, 2.40 g/L	42 (avoid using after fruit set)
27.	Carbendazim 50 WP, 46.27 SC	1.0 g/L, 1.0 mL/L	50
IV Flea beetles			
28.	Imidacloprid 17.8 SL	0.30 mL/L	60
29.	Lambda-cyhalothrin 05 CS	0.50 mL/L	30

Sr. No.	Chemical recommended for major disease & pest	Dose on formulation basis	Pre-harvest Interval (PHI in days)
V	Thrips		
30.	Emamectin benzoate 05 SG	0.22 g/L	25
31.	Fipronil 80 WG	0.05 g/L	60
28a.	Imidacloprid 17.8 SL	0.30 mL/L	60
29a.	Lambda-cyhalothrin 05 CS	0.50 mL/L	30
VI	Jassid		
28b.	Imidacloprid 17.8 SL	0.30 mL/L	60
29b.	Lambda-cyhalothrin 05 CS	0.50 mL/L	30
VII	Mealy bugs		
32.	<i>Buprofezin 25 SC</i>	1.25 mL/L	40
33.	<i>Methomyl 40 SP</i>	1.0 g/L	61 (one application only at pre-flowering stage)
VIII	Caterpillar (<i>Helicoverpa armigera</i> and <i>Spodoptera litura</i>)		
29c.	Lambda-cyhalothrin 05 CS	0.50 mL/L	30
30a.	Emamectin benzoate 05 SG	0.22 g/L	25
IX	Mite		
25a	Sulphur 80 WDG	1.50-2.0 g/L	15
X	Plant Growth Regulators		
34.	Hydrogen cyanamide 50 SL	30-40 mL/L	90-120
35.	Forchlorfenuron (CPPU) 0.1% L	1-2 ppm	22 (for 1 ppm dose) 30 (for 2 ppm dose)
36.	Gibberellic acid (GA3) Technical	100 ppm (Cumulative Usage)	7
37.	1-Naphthyl acetic acid 4.5% L	100 ppm	PHI data not available
38.	Chlormequat chloride 50 SL	250 ppm	PHI data not available
XI	Herbicides		
39.	Paraquat dichloride 24 SL	5 mL/L	PHI data not available

NS = Non-systemic, S = Systemic

Note

- All the doses mentioned above are for high volume sprayers, where normal spray volume is 1000 L/ha. Spray volume can however be changed as per the efficiency of sprayers used. However, the amount of each pesticide based on its active ingredient recommended for 1 ha area on the basis of 1000 L spray solution should be strictly maintained to minimize pesticide residues.
- Recommended PHI will be valid only if two applications of an agrochemical are given per fruiting season at the interval of 7-15 days at recommended dose except in case of Flusilazole and Methomyl.
- The PHI of the fungicide Flusilazole and insecticide Methomyl pertains to one application by foliar spray only.
- Imidacloprid (17.8 SL) application (spraying or soil drenching) should not exceed more than two times per fruiting season.

Pesticide residues during wine making

The winemaking process begins with the pressing of the grapes by forming a biphasic system made up of the must (an acid aqueous liquid phase with pH 2.7-3.7) and the pomace (a solid phase which contain cake and lees). The following step is fermentation and this process can be carried out either with or without grape skins. In the former case (with maceration) the wine will be made with all of the residues on the grapes; in the latter case (without maceration) the process will include only the residues that have passed in the must. The grape pomace (cake and lees) is the main by-product from winemaking.

The fate of pesticide residues on grapes during winemaking has been widely studied. In most reported data, pesticide residues present on grapes remain adsorbed in the cake and lees (which are by-products of wine-making) at relevant levels, and are transferred to the wine in low percentages after fermentation depending, mainly on the initial partition of a pesticide residue between the must and the cake and lees. Several pesticide residues have been reported to be transferred from the grapes to the wine at relevant amounts (20-30% for all pesticides but benomyl that transferred 100%). However, the partition coefficient of a pesticide residue between the solid pomace phase and the liquid phase of must that mainly depend on the K_{ow} and water solubility of the pesticide is not the only parameter that defines pesticides fate during wine-making. Yeasts that usually are being used in vinification processes have shown the ability to degrade some pesticides belonging to the pyrethroid and thiophosphate classes. Among the clarifying substances commonly used in wine (bentonite, charcoal, gelatin,

polyvinylpolypyrrolidone, potassium caseinate, and colloidal silicon dioxide), comparatively charcoal allowed the complete elimination of most pesticides, especially at low levels, whereas the other clarifying substances were ineffective.

Conclusions:

After the establishment of this Centre, the quality of Indian grapes with regard to its pesticide residues has improved significantly with no rejection of any export consignment in the international market over last seven years. The extent of export as well as price realization by the growers also significantly improved.

To minimize pesticide residues in grapes, this Centre prescribes the followings:

- Use only the recommended pesticides
- Do not spray banned as well as non-recommended chemicals
- Strictly adhere to the recommended dose of application including the recommended volume of water to be sprayed per hectare or per acre.
- Strictly maintain recommended Pre-Harvest Interval to minimize consumer risk regarding detection of residues
- Integrated Pest Management involving minimal usage of highly toxic chemicals
- Sequencing the pesticides in relation to their persistence particularly in the last 2 months period before harvest
- Adoption of Bio-control measures during last 30 days before harvest
- “Combination Products” which contains two or more active ingredients as given in the above list can be used. However, the dose of the individual active ingredient should not exceed the recommended dose.

Chapter 11

Certification Requirements of Wines for Export to the European Union and Other Countries



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Dr. Sagar
Utture
Chemist,
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The quality of the wine can be assessed by its physical, chemical and microbiological aspects. The physical aspects viz., colour, flavor, taste, etc are monitored during the winemaking process. Apart from these physical parameters, chemical aspects of the wines is of major concern since those are directly related to human safety and hence the governing bodies like European Union (EU), USA, India have set the maximum acceptable limits for the chemical contaminants in the wine. In all Member States of EU and many third countries, the overarching principles concerning food safety and consumer protection are established in national legislation. In India, Bureau of Indian Standards (BIS) has set the limits for Indian wines and those are also applicable for the wines imported from other countries but these standards are not based on the scientific data. Similarly Food Safety and Standards Authority of India (FSSAI) have set limits of certain chemical contaminants however those are not specifically applied to wines.

Certification of wines is an absolute guarantee to the public that the claims made on the packaging about the wine are true and that the wine is of good quality. Samples of all wines which are submitted for certification are scientifically analysed to determine whether all the legal

requirements for export have been met and also to ensure that the wines are fit for human consumption. Monitoring of quality parameters of wine and levels of chemicals used in the winemaking process is becoming a major concern for food regulators. In view of its fitness for human consumption, it is therefore essential that adequate monitoring through proper surveillance should be in place to eliminate the possibility of rejections of the wine consignments by the importing countries in cases of their unfitness of human consumption in view of detection of chemicals unauthorized in wine or the levels above the specified limits. Accordingly, it is necessary to check/verify the wine quality parameters in the wines exported to the European Union (EU) as well as other countries following EU food safety norms.

Every step in the winemaking process is important to prepare quality wines and this starts from the wine grape cultivation itself. It is important to follow the good agricultural practices (GAP) for wine grape cultivation in order to get good crop as described in earlier chapters of this document. Apart from this, for wineries good manufacturing practices (GMP) are recommended. GMP is referenced to prescribe the maximum limit of many additives and processing aids used rather than imposing specific

quantitative limits. The three general inter-related principles involved in assessing compliance with GMP include:

- a) The quantity of the additive added to food shall be limited to the lowest possible level necessary to accomplish its desired effect
- b) The quantity of the additive added to food shall also be limited to the Codex additive level necessary to comply with regulatory requirements
- c) The additive is handled in the same way as a food ingredient

GMP alone, however, is not a HACCP analysis nor a quality assurance (QA) system.

It is important that the wineries should only use food grade additives and processing aids during winemaking process and keeping the record of the use of these chemicals is a good practice. The acceptability of wines manufactured in HACCP and ISO certified wineries may be more.

All these factors will help in increasing the acceptability of the wines in the domestic as well as international market.

As far as export of wines is concerned the wine consignments should accompany VI 1 certificate issued by the country of origin. A sample copy of the VI 1 certificate is given below.

This certificate includes the certificate issued by a certifying body stating that the product is meant for direct human consumption and is prepared by following the oenological practices recommended and published by OIV (Annexure). Before certifying the wines fit for human consumption, analysis of VI-1 parameters viz., total alcoholic strength, actual alcoholic strength, total sulphur dioxide, total dry extract, volatile acidity, total acidity, citric acidity is essential. The VI 1 certificate also covers analysis report issued by approved testing laboratories.

LIST OF OFFICIAL AGENCIES**[To be listed in Column 2 of Document IV (Article 29 of Commission Regulation No. 883/2001 published in C 139 of 05.06.2008)]**

1. National Research Centre for Grapes
Indian Council of Agricultural Research (ICAR)
P.B. No. 3 Manjri Farm Post Solapur Road
Pune 412 307
Phone: 020-2691-5573, 2691-5574, 2691-4245
Fax: 020-2691-4246
E-mail: nrcgrapes@gmail.com
2. Central Food Technological Research
Institute (CFTRI)
VV Mohalla
Mysore 13
Karnataka State
Phone: 0821-2517760, 2514972
Fax: 0821-2516308
E-mail: ttbd@cftri.res.in
3. Indian Institute of Integrative Medicine
(Formerly Regional Research Laboratory)
Council for Scientific and Industrial Research (CSIR)
Quality Control & Assurance Division
Canal Road, Jammu Tawi 180 001
Phone: 0191-2569022/2569000-06
Fax: 0191-2569022/2569333
E-mail: jkdhar@iim.res.ac.in; jkdhar011@yahoo.com
4. National Horticultural Research and
Development Foundation
NHRDF Research Complex
Chittegoan Phata PO Darna Sangvi
Taluka Niphad Distt. Nashik 422 001
Phone : 02550-202422, 237816, 237551
Fax: 02550-237947
E-mail: nhrdf_nsk@sancharnet.in; nhrdf_npd@bsnl.in
kjsrivastava@yahoo.com

APEDA RECOGNISED LABORATORIES
To be listed in Column 3 of Document IV (Article 29 of Commission Regulation
No. 883/2001 published in C 139 of 05.06.2008)]

- 1) Arbro Pharmaceuticals Ltd
 4/9 Kirti Nagar Industrial Area
 New Delhi – 110 015, Delhi State
 Telefax:0091-11-45032722
 Phone : 011-45072316, 45072317,45072318, 45072346
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- 2) Delhi Test House
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Chapter 12

Implementation of Winenet in Maharashtra



Govind Hande
Horticulture Officer

Grape is one of the most commercially important crop of the world and is a fairly good source of minerals like calcium, phosphorous, iron and vitamins like B1 and B2. Its juice is mild, laxative and acts as stimulant for kidneys. It is one of the most ancient crops known to man.

Among all fruit crops Grape is one of the major crop in India with 84,400 hectares cultivated area & 18 Lakh MTs annual production. Maharashtra state is a leading state in cultivation, production and export of grapes in the whole country. In Maharashtra, total area under grape cultivation is 65,000 hectares with annual production of 15 Lakh MTs of grapes. In Maharashtra among all districts Nasik, Sangli, Solapur, Pune, Ahmednagar, Latur, Osmanabad and Satara are main grape producing districts. In the state major grapes are produced for eating purpose (98%) and limited quantity (2%) is utilized for production of dry fruit like raisin and grape juice, syrup, jam, jelly, wine etc. Every year production of raisins in Maharashtra is about 60,000 MTs and about 70,000 to 80,000 MTs of fresh grapes are exporting from Maharashtra state to different countries.

However, due to natural calamities or sudden changes in weather conditions the quality of grapes is affecting. Thereby farmers get low price for their exportable grapes and also in the local market, the average price realized by the farmer is less i.e. around Rs. 8 – 10 /Kg. This situation further aggravated by

unscrupulous middleman, who deceive farmers by not paying even the basic cost of cultivation. There are 16 bi-products which are made from grapes viz. raisin, grape juice, squash, syrup, jam, jelly, vinegar, wine, pickles, chocolates, tartaric acid, oil, cattle feed, tannin etc. But looking to the world scenario of different bi-products, it was necessity to consider setting up of projects for manufacturing other value added products from grapes, such as good quality of **WINE** so as to prevent losses, obtain more income and provide additional employment to rural people in Maharashtra. It was also observed that if the farmers in the state cultivate peculiar types of wine grapes varieties and make good quality of wine from them, then they can get more income from domestic and export markets.

Keeping in view the above objectives, the Government of India has announced **Agri Export Zone (AEZ)** for Nasik, Sangli, Pune, Solapur, Ahmednagar, and Satara for Grapes and Grape Wine Park in Maharashtra. The concept of **Agri Export Zone (AEZ)** is to take a comprehensive look at a particular produce located in a contiguous area for the purpose of developing and sourcing the raw material, processing, packaging and preservation leading to export of the produce and value added products. The effort is mainly center around a cluster approach of identifying a particular crop / food item grown in the area and providing and integrating entire process from

production to marketing. The objective of AEZ is to provide remunerative returns to the farming community in a sustained manner and to increase their competitiveness.

To give impetus to the grape processing and wine industry in Maharashtra state and for the benefit of farmers & entrepreneurs, the Government of Maharashtra has declared the “**Maharashtra Grape Processing Industrial Policy 2001**” on 19th September, 2001. Salient features of this policy are :-

1. Declared as a preferential area.
2. Declared as a small scale industry.
3. 100 % exemption from excise duty for 10 years.
4. Relief in sales tax levels (from 20% to 4%).
5. Single window clearance facility.
6. Licensing procedure for new wine units and wine sales vastly simplified.
7. Units will have status of “ Food Processing Industry.”
8. Establishment of “Wine Institute” to train the farmers and “Maharashtra Grape Board” and “Indian Grape Processing Board” to promote the wine industry and exports.

This Government Policy aims at sustaining wine grape cultivation & wine industry in India general & Maharashtra in particular. Hence interest of table grape grower gradually switching over to grape wine varieties.

Memorandum of Understanding between the Government of India (Agricultural and Processed Food Products Export Development Authority, **APEDA**) and Government of Maharashtra (Maharashtra Industrial Development

Corporation, **MIDC**) for development of **Agri Export Zone (AEZ)** for Grapes and Grape Wine made on 7th January, 2002.

The Government of Maharashtra has nominated **Maharashtra Industrial Development Corporation (MIDC)** as a **Nodal Agency** for establishment of grape wine parks in Maharashtra state and would co-ordinate efforts of various organizations from Central and State Government and also be the main link between the Central and State agencies and the stakeholder (Farmers, Processors, Service, Providers, etc.).

So as per the Government policy MIDC is developing initially **Godavari Wine Park** at Vinchur, district Nasik and **Krishna Wine Park** at Palus, district Sangli. The role of MIDC is to provide mainly land to entrepreneur at reasonable rate and to provide infrastructure facilities like high quality internal roads, water supply, effluent treatment plant, quality control and analytical laboratory, power and telecom facilities, mother.

The location of Godavari Wine Park is on Nasik-Aurangabad highway. From Nasik city is about 53 km and 233 km from Mumbai. Krishna Wine Park is near Pune-Bangalore national highway. From Sangli city it is about 40 km and 300 km from Mumbai. In wine park of Nasik initially 97 plots and in Sangli 107 plots have been developed for winery activities with average plot size of 2000 sqmts in both wine parks.

In order to create an awareness of the advantages of grape processing, MIDC and BharatiVidyapeeth Deemed University, Pune have been taken up a joint project to train farmers in this area. So BharatiVidyapeeth have been established **Grape Processing and**

Research Institute in Krishna Wine Park, Palus, Sangli. The objectives of wine Institute is:-

1. To give training to the farmers through various courses like certificate or diploma or degree in cultivation of wine grape varieties, manufacturing of good quality of wines and marketing of wines.
2. To set up a nursery of grape wine varieties to provide authentic plantlets to farmers.
3. Manufacturing of good quality of wines in a pilot plant for demonstration purpose.
4. To set up quality control laboratory for wines.
5. Impart blending techniques.
6. Explore domestic and international markets.
7. Set up a 'Mother Unit' for processing of grapes to help the farmers for manufacturing of wines.

Like Sangli, in Vinchur, Nashik also MIDC have been set up '**Mother Unit**' to help the farmers for manufacturing of wines. The concept of mother units to set up common facility to the grape processors for the equipment such as pneumatic press, crusher, destemmer, filtration unit, bottling unit, quality control lab, cold storage (cellar), packaging house and the services of wine master and wine tester which are very costly and required for short period of 2 to 3 days to 2 weeks in a season.

In India, the place Nashik, the holy place since ages & since last to decades, developed as a growth centre of Industries, along with the grape growing region of the country & now upcoming as the Wine Capital of India.

The land of Nashik is a haven for growing internationally the

acclaimed table & wine making grapes. Nestling at the feet of Sahyadri Hills, Nashik is endowed with a suitable soil. Its pleasant, dust free & non-corrosive climate, matches the topography of the South France, making it conducive for the growth of the wine fruit. Nature has endowed the picturesque valley – the home vintage wines with a wealth of nature resources.

Like Nashik, Sangli Valley is situated in great royal belt of the Sahyadrys is a wine region of the great individuality.

Both the terrior is suited to the production of a well structured wines that take full advantage of this temperature climate characterised by cold winters and warm sunny summers with a average rain fall of 240 mm P.A. Modern viticulture methods are applied through out the vineyards to ensure optimum quality in wine is achieved. In the cellar too, the latest technology is applied to ensure that all the wine produced is both flavorful and solid quality to ensure enjoyment.

Combining tradition and modern technology in full respect of the environment comes from both region choosing and proposing wines originating from the most qualified Indian regions. To make a quality wine four components are decisive, soil, climate, vines and human factor that is the people who make wines and by trying to find the ideal balance between the characteristic of soil, the microclimate and the grape varieties ideally suited to their circumstances.

Also studies are carried out on land, in order to optimised the marriage between variety and terrior. The vineyards are planted on the best virgin rocky soils with excellent natural drainage in the royal belts of the Sahyadrys in India.

Both the valley is well reputed, on world map for quality grape growing & since the quality grapes are the essentials of the wine making, both valley are the leader in the same.

Wine grapes & vineyards developed since last few years are internationally recognized & some of the wines are exported to the European Countries.

Now in Maharashtra total 6,775 to 7,000 acres area are under cultivation of wine grape varieties and it is increasing day by day to meet the demand of new coming up grape wine units. In 2010 there are total 74 (36 in Nasik, 13 in Sangli, 12 in Pune, 5 in Solapur, 4 in Osmanabad, 3 in Buldana and 1 in Latur District) grape wine units are already gone in production in Maharashtra state. From 2001, every year average 7 to 8 wine units are gone in production in Maharashtra.

At present total production of wine in India is 1.45 Crore liters (at present in India total 90 wineries are established). Out of that 1.32 Crore liters wine is produced only in Maharashtra by 75 wineries. The total investment on wineries of Maharashtra was Rs. 431.71 Crore in 2009 and raised to Rs. 452.10 Crore in 2012.

Today, wine has become an integral part of any social occasion, i.e. marriages, festivals, entertainment. France, Italy, Spain, Germany are the main grape wine producing countries in the world. Nearly 32,000 million liters wine is produced per annum in the world. India currently imports 72,000 wine cases (nine liters to a case) a year. About 32,000 of this Bottled in Origin and the other 40,000 cases are imported in bulk flexi bags, which are subsequently bottled by Indian wineries. Besides this, about 12,000-15,000 wine cases are sold through gray market.

The Indian market is way behind heavy wine drinking countries like France & Italy where consumption of wine is 60 to 70 liters, in USA 25 liters, in Australia 25 liters, while in China consumption is 4 liters per person per year. But in India consumption of wine per person per year is literally a sip of 9 to 10 ml. But the Indian market has been growing at about 30 to 40 % every year according to a survey conducted recently by Rabo International Bank and is expected to grow at this rate for the next 5 – 6 years in keeping the world trends.

The recent quantum jump in wine consumption is ascribed to increasing disposable incomes, changing lifestyles, easier availability and greater awareness due to factors wine testing sessions, setting up of wine clubs, wine bar, media coverage etc. In 2009-2010, approximately 7.00 lakhs liters of wine (Rs. 5.92 crore) is exporting to France, Italy, Germany, USA, New York, U.K., Singapore, Belgium from Maharashtra State. The Biggest consumption up to 80 % is however confined to major cities like Mumbai (39 %), Delhi (23 %), Bangalore (9 %) and the foreign tourist dominated state of Goa (9 %) where as rest of India has only 20 % consumption.

In case of prospects for Indian wine market, there is huge potential in India market itself. For export market, the increasing popularity of Indian cuisine is an automatic opening. With more and more professionals visiting India on regular basis, and the fact that Indian wine exports are going up every year, word is getting spread every fast creating awareness of Indian wines in International market. The wine industry in India is in its nascent stages now, to follow quality parameters will go a long way in making wines from

India as a brand in international market, the same way Australians and Chileans have achieved. With a result that Australian wines have taken over French wines as No. 1 sellers in UK market, both quantity and value wise, apart from the more obvious fact that they are more value for money. If Australia, Chile and US can become leaders in wine exports over just 10 years of operation, there is no reason why Indian wines cannot achieve such status.

Government of Maharashtra State , Agriculture Department had taken a lead and played a major role for implementation of Grapenet and resultant increased export of fresh grapes to European Union by carrying out farm Registration , Inspection and Phytosanitary Certification of export consignment including Monitoring Pesticide Residues etc. During 2012-13 season 17765 grape growers are registered under Grapenet for export of grapes to European Union .

Ministry of Food Processing Industries , Government of India has taken a decision to implement winenet certification and traceability system in Maharashtra state from 2012-13 season on the basis of Grapenet .

The main objective of winenet is to introduce traceability system for wine grape growers and wineries not only to bring the credibility to Indian Wines abroad but also improvement in quality and branding of Indian wines . This initiative is likely to improve the supply chain management in the country on par with that of other advanced countries, thereby bringing more commercial value to wine grape growers and Wineries. This step is likely to increase the domestic consumption of wines due to improved quality.

Accordingly Joint Secretary, Ministry of Food Processing Industries , Government of India , requested to State Government of Maharashtra , Agriculture Department to implement winenet traceability system for monitoring of pesticide residues in wine grapes in Maharashtra state from 2012-13 season on the basis of Grapenet .

Maharashtra State has decided to implement the winenet system in the state for registration , Inspection and certification for monitoring of pesticides residues in wine grapes .

State Initiatives taken for Implementation of Winenet in Maharashtra

- Monitoring Cell established at State Level under Director Agriculture (Input and Quality Control) Commissionerate of Agriculture Pune for monitoring of RMP Vine Grapes Activities
- Three tier system is adopted for Winenet implementation i.e Taluka, District , State
- District Head District Superintending Agriculture Officer of 8 district are appointed as Registration Authority for Vine grape Garden under Winenet
- Taluka Head are appointed as Inspecting and Coordinating officer for registration, and inspection of vine garden in 4A & 4B
- 33 Inspecting Authorities are appointed-for inspection of registered Vine garden and proper guidance to the Vine growers regarding pest and diseases and use of approved chemicals and maintainance of record in prescribed format
- Through SMS System Messages are given to Vine grape growers

and Field officers from State and District level

- Detail working guidelines are prepared and made available to all field officers
- Special drive taken for registration Vine grape garden for the season 2013(1st January 13 to 31st January 2013) For collection of application for new registration of Vine grape garden . 1000 vineyards growers are identified for registration under Winenet
- Training are given to Field officer for effective implementation of Winenet
- Wineries list are prepared and made available to all Registration and Inspecting Authority
- RMP for Wine grapes draft is prepared and submitted to Ministry of Food processing approval
- A proposal for financial support for implementation of Winenet in

Maharashtra is submitted to State Agro processing Mission for 2012-2013 season.

As per the request of Joint Secretary, MOFPI, New Delhi , Team of Expert from Maharashtra state visited to Karnataka State on 22nd January 13 at Bangalore for educating to field officer regarding implementation of winenet system

Nasik- 4000

Sangli- 700

Pune-700

Solapur- 700

Osmanabad- 350

Latur- 350

Buldhana- 100

Anagar- 50

Total – 7000 Acre