## Chapter II

# REVIEW OF LITERATURE

# Review of literature

Grape (*Vits vinifera* L.) is most important fruit crop grown in Maharashtra for its refreshing and nourishing fruits. It is an important cash crop like sugarcane to the farmers in Western Maharashtra, especially the districts like Satara, Sangli, and Kolhapur. In recent years, this fruit crop is heavily damaged causing severe economic loss to the cultivars due infection of various diseases at the time of fruit formation i.e. downy mildew, powdary mildew, mealybugs etc. The downy mildew creates greater loss up to 80 % to 90 % to the farmers.

The use of fungicides, pesticides for controlling downy mildew and other diseases of grape are not found suitable as they cause residual effect on the grape. The quality, taste and structure of berry also alter hence; these grapes are not found suitable for human beings as well as for export to foreign countries. Last 5-6 years most of the grape cultivators use leaf extracts of *A. cantala* for controlling the downy mildew as a traditional method. There practices suggest control of the diseases to some extent which does not alters the grape quality. The practices suggest control of the diseases to some extent physiological mechanism behind the control of these diseases is still unknown to the workers.

The present attempts are made to investigate pathophysiological aspects in the grape plants one which are infected with downy mildew and those which are sprayed with Agave leaf extract, to study disease controlling mechanism. The present studies are made on nutritional aspects; enzymes mechanisms in diseased grape plant sprayed with *A. cantala* leaf extract. The observation will throw some light on new biological controlling mechanism systems developed due to interaction of Agave leaf extract and pathogenic activities.

The present chapter on review of literature includes: a) the study of grape in relation to disease incidence by use of chemical and biological control measures adopted by workers. b) The literature on Agave gives emphasis on cultivation, economic importance, phytochemical studies and antifungal

properties of the Agave species. In addition, c) literature on side effects of chemical control on crop for disease control is included.

The overall information given in the literature suggest the importance of application of *Agave cantala* leaf extract for disease control in grape plant, instead the use of chemical control measures.

## A] Review of literature on Grape

### 1) Introduction:-

Grape (*Vitis vinifera* L.) is one of the most important sub-tropical fruit crop. It is cultivated in more than 60 countries, with 9 million ha. area under cultivation (Singh *et al.*, 2005). In India, grape is cultivated in states like Karnataka, Maharashtra, Tamilnadu and Andhra Pradesh. It is well known as nutrition source of natural sugars, vitamins and fiber. It also has some medicinal properties (Khare, 2003). It is with great cultural significance, tradition, habit, art and even religions have accompanied the development and domestication of grape throughout human history (Unwin, 1991; Martinelli, 1997).

Grape is cultivated mainly for raisin, wine and table purpose. According to USDA (2002), the major food products made from grapes are, wine- 50-55%, raisin- 25-30%, table- 10-15%, canned- <1 % and juice, jelly etc.- 6-9%. Percapita consumption was 19.1 lbs/ year in the form of 41%fresh, 36%raisin, 22%juice and 1 % canned. The wine consumption is 2 gallons per year.

**Table No: 1.1 Dietary values, per 100 g edible portion of Grape, USDA (2002)**

| | **Grapes** | **Raisins** | Wine (100g = 4 oz) |
|---|---|---|---|
| **Water (%)** | 81 | 18 | 90 |
| **Calories** | 67 | 289 | 70 |
| **Protein (%)** | 0.6 | 2.5 | Trace |
| **Fat (%)** | 0.3 | 0.2 | 0 |
| **Carbohydrate (%)** | 17 | 77 | 1-2 |

| Crude Fiber (%) | <1 | - | 0 |
|---|---|---|---|
| | | % of US RDA* | |
| **Vitamin A** | 2.0 | 0.4 | -- |
| **Thiamin B1** | 3.6 | 7.8 | Trace |
| **Riboflavin, B2** | 1.9 | 5.0 | Trace |
| **Niacin** | 1.7 | 2.8 | Trace |
| **Vitamin C** | 9.0 | 2.2 | 0 |
| **Calcium** | 1.5 | 7.8 | <1 |
| **Phosphorous** | 2.5 | 12.6 | --- |
| **Iron** | 4.0 | 35 | 40 (red only) |
| **Sodium** | --- | 0.6 | <1 |
| **Potassium** | 3.7 | 16 | 1-2 |

## 2) Origin and history of cultivation:-

*Vitis Vinifera* is thought to be native to the area were the Caspian sea, in south-western Asia, the same region where apple cherry, pear and many other fruits are native (Snyder, 1936; Winkler, 1970). Seeds of grapes were found in excavated dwelling of the Bronze Age in South Central Europe (3500-1000 B.C.), indicating early movement beyond its native range. Egyptian hieroglyphics detailed the culture of grapes and wine making in 2440 B.C. The Phoenicians carried wine cultivars to Greece, Rome and southern France before 600 B.C., and Roman spread the grape throughout Europe. Grapes moved to the Far East via traders from Persia and India. The table grape and raisins were used around eastern regions of Mediterranean Sea to North Africa before it is introduced to Europe (Winkler, 1970).

Grapes are introduced in India by Muslim invaders in $12^{th}$ century from Iran and Afghanistan. These grapes were shifted to south India by them (Shanmugavelu, 2003). Earlier varieties such as Abi (Bhokri), Fakhri and Sahebi are introduced by them. However, there are some reports which shown the cultivation of grapes in the period of Susruta and Charaka (1356 B.C)

(Khare, 2003). Aryans knew about grape culture as well as preparation of beverage from it (Shanmugavelu loc. cit.).

## 3) Taxonomic position:-

Grape belongs to the family Vitaceae. Vitaceae is considered under the order of Rhamnales, characterized by wood plants with unisexual flowers. There are two families Vitaceae and Rhamnaceae under Rhamnales (Lawrance, 1951; Rendle, 1956).

The genus *Vitis* is broadly distributed, largely between $25^0$ and $50^0$ N latitude in eastern Asia, Europe, the middle, East and North America, *Vitis* is split into 2 subgenera viz., Euvitis and Muscadinia.

Euvitis (2n = 38) known as "True grapes" having elongated clusters, berries that adhere to stems at maturity, forked tendrils, loose bark that detaches in long strips and diaphragm in pith at nodes. Muscadinia (2n = 40) known as "muscadine grapes", small fruit clusters, thick- skinned fruit, berries that detach one-by-one as they mature, simple tendrils smooth bark with lenticels and lack diaphragms in pith at nodes. Vitaceae has 14 genera and over 1000 species (Pearson and Goheen, 1988).

Muscadinia is now considered as a separate genus (Sing and Murthy, 1991). About 70 species reported under genus *Vitis*. Species under different genera are *Vitis* (6) *Cissus* (21), Caryatia (12), Tetrastigma (15) Ampelocissus (10), Parthenocissus (3) Ampelopsis (2) and Lee (33).

## 4. Distribution in India:-

The genus *Vitis* is broadly distributed largely between $25^0$ and $50^0$N latitude in eastern Asia, Europe, the Middle East and North America. In India, states like Andhrapradesh, Haryana, Karnataka, Maharahstra, Punjab and Tamilnadu are known for grape cultivation. Other states like Uttar Pradesh, Rajasthan and Himachal Pradesh are having few areas under grape cultivation (Shanmugavelu, 2000)

Climatic conditions in India are very different from the major grape growing countries of the world. Characteristic features of Indian grape cultivation are array of climate and soil, evergreen nature of vines without entering into dormancy in subtropical and tropical regions of the country, greater degree of apical dominance and heavy fertilization.

India comprises two zone of viticulture.

**A) Subtropical zone:-**

In this region temperature rarely reaches to freezing point, this region receives rain during January- September. The rain in June damages berry by cracking and rotting. It is period of berry ripening. The important variety like Thompson seedless causes more damage due to its high sugar contents and long ripening period thus, to avoid this damage farmers cultivated grape varieties having early maturity e.g. Perlette and beauty seedless. Another c.v. Anab- E- Shahi is also cultivated because it is not very susceptible to berry cracking and rotting. The states like Punjab, Haryana, Uttar Pradesh, Rajasthan are comprised in sub- tropical zone.

Part of peninsular India receives rain from south-west monsoon during the months of June-September. The parts of states such as Andhra Pradesh-Telangana and Rayalseema without Chittor and Prakasam districts and interior Karnataka with rain shadow areas of Western Ghats of Maharashtra.

**B) Tropical Zone:-**

Climatic conditions in this zone are hot and humid. This zone receives rainfall during May to November from both south- west and North-East Mansoon. Tamilnadu and districts of Bangalore, Kolar, and Mysore of Karnataka are in this zone having majority of area under grape cultivation.

At present there are about 40,000 hectares under grape cultivation in the country. The state wise areas are increasing rapidly. State wise area under grape cultivation is as following (Shanmugavelu, 2003):

| State | Area (in hectares) |
|---|---|
| Punjab | 500 |
| Haryana | 400 |
| Andhra Pradesh | 1500 |
| Karnataka | 4200 |
| Tamilnadu | 1500 |
| Maharashtra | 20000 |

The major grape growing area of Maharashtra is situated in districts like Nasik, Pune, Sangli, Kolhapur, Solapur, Satara, Jalgaon, Ahmednagar, Amaravati, Nagpur, Parbhani and Aurangabad.

## 5. Morphology:-

All *Vitis* are "lianas' or woody, climbing vines. Tendrils occur opposite to leaves at node, and automatically begin to coil when they contact another object. Vinifera and American bunch grapes have loose, flaky bark on older wood, but smooth bark on 1-year-old wood. Muscadine vines have smooth bark on wood of all ages. Leaves vary in shape and size depending on species and cultivars. Muscadine grapes have small (2-3) round unlobed leaves with dentate margins. Vinifera and American bunch grapes have large (up to 8-10" in width) cordate to orbicular leaves, which may be lobed. The depth and shape of the lobes and sinuses (space between lobes) varies by cultivar. Leaf margins are dentate.

Flowers are small (1/8 inch), indiscrete, and green, borne in racemose panicles opposite leaves at the base of current season's growth. There are 5 each sepals, and stamens. Ovaries are superior and contain 2 locules each with 2 ovules. The calyptra or cap is the corolla, in which the petals are fused at the apex; it abscises at the base of the flower and pops off at anthesis. Species in *Euvitis* may have 100+ flowers per cluster, whereas muscaline grapes have only 10-30. Vinifera and Concord grapes are perfect- flowered and self-fruitful, where as some muscadine cultivars have only pistillate flowers. Flowering in

grape occurs at the basal nodes of current season's growth in all species. Perfect flowered muscadines have longer stamen, while the pistillate flowers have short, refluxed stamens.

Grapes are true berries; small (<1inch), round to oblong, with up to 4 seeds, Berries are often glaucous, having a fine layer of wax on the surface. Skin is generally thin and is the source of the anthocyanin compounds giving rise to red, blue, purple and black (dark purple) coloured grapes.

## 6. Propagation:-

Grapes are propagated through two methods. Propagation through seeds mainly used for evolving new hybrid variety through hybridization. In asexual method (vegetative) grape plants are multiplied by means of vegetative parts. The most common technique of vegetative propagation in grape is hard wood cuttings. However, the vines are also propagated by other means such as budding. Grafting, layering and tissue culture (Singh *et al.*, 2005).

**Rootstocks:-**

In India, rootstocks have been employed in commercial viticulture. Due to increase in problems of soil salinity, drought, nematodes and poor fruitfulness of varieties, the need for rootstocks has been felt in India viticulture during past few years. Ability of Rootstocks to combat against the soil problem and a potential to manipulate the vine growth and productivity are main reasons to use it. Now a days rootstocks have been identified for various problems by studying effects on vine growth which is highly resistant to root rot nematode as well as to soil salinity is used as a prime rootstock in Indian viticulture (Singh *et al.*, 2005).

## 7. Factors influencing growth of grapes:-

There are many factors which influencing growth of grapes. Soil, climate, irrigation and nutrient requirement are major factors essential for grape.

**a) Soil:-**

Grapes are adapted to a wide variety of soil conditions from high pH and slight saline to acidic and clayey. Deep, well drained, light textured soils are best for wine grapes. Highly fertile soils are unsuited to high quality wine production since vigor and yield must be controlled. The light and sandy loam soils of the north western India are excellent for growing grapes. Grape cultivation in Maharashtra is widely done on heavy black soil with high clay. Karnataka and Andhra Pradesh has well drained red soils, and with low water holding capacity. According to Shanmugavelu (2003), soil type is responsible for differential growth in grape varieties.

**b) Climate:-**

Climatic conditions play an important role in the vine growth, productivity and quality of fruits which tends to successful cultivation of grape. The ideal climate for the grape is in the Mediterranean region. According to Winkler *et al.,* (1974), higher elevations are suitable for grape development. Grape can stands for extreme temperature ranging from -20$^0$C in winter to 45$^0$C in summer Temperature range from 15$^0$C to 35$^0$C is ideal for short growth and normal physiological processes of the grapevine (Singh *et al.*, 2005). High temperature can cause small berry size and poor sugar content while extreme low temperature can cause cracking of berry.

High humidity is unsuitable for grape cultivation, causes serious fungal diseases (Bilgrami *et al.*, 1976) and pests (Atwal, 1976).

**c) Irrigation:-**

Grapevines requires the sandy soils, which having low water holding capacity and well-drained. It requires light but frequent irrigation. Irrigation through dripping system is best way to irrigate vineyards (Singh *et al.,* 2003). However, grape vines, are more drought tolerant as compared to other fruit crops. For the saline soils, frequent irrigation has to be applied to leach the salts. Grape cultivations generally withhold irrigation before harvest, to increase the quality of berries. On an average about 15 irrigations are necessary per season (Shanmugavelu, 2003).

**d) Nutrient requirements:-**

Grape requires additional nutrients in the form of manures. The application of nutrients is mainly based on soil type, climatic condition and grape varieties (Sharma, 2006). According to Shanmugavelu (2003), nitrogen requirement per vine plant is ranges from 1.5 to 2.8 kg, phosphorous 0.56 to 1.36 kg. per vine and potassium from 1.00 to 2.5 kg. per vine. The macro and micro nutrient requirement for cv. Thompson seedless is given below:

**Table No.1.2 Nutrient requirements for cv. Thompson seedless (Sharma, 2006)**

| **Macronutrients** | **Kg/ha/year.** |
|---|---|
| Nitrogen (N) | 22-84 |
| Phosphorous (p) | 5-35 |
| Potassium (k) | 41-148 |
| Magnesium (Mg) | 6-25 |
| Calcium (Ca) | 28-204 |
| **Micronutrient** | **g/ha/year** |
| Iron (Fe) | 292-1121 |
| Boron (B) | 37-228 |
| Manganese (Mn) | 49-787 |
| Zinc (Zn) | 110-585 |
| Copper (Cu) | 64-910 |

Excessive use of chemical fertilizers can cause soil pollution and lowers production grape. Hence, Organic farming is now widely followed by vine cultivators. It includes farmyard manures, vermicompost and ground nut cake etc. (Sharma, 2006).

## 8) Pests and diseases:-

There are several fungal diseases and pests reported on grape vine. Grape is one of the very susceptible fruit crop to many diseases. These diseases cause severe loss in production every year. Climatic conditions play major role in infection. Almost all parts of grape vine are attacked by pathogens.

These diseases and pests are depicted in Table No. 2.2 with their causal organism.

**Table No. 1.3: Major diseases and pests**

| Sr.No. | **Diseases** | **Pathogen** |
|---|---|---|
| 1 | Downy mildew | *Plasmopara vitcola* (B. & C.) |
| 2 | Powdary mildew | *Uncinula necator* (Schw) |
| 3 | Anthracnose | *Gloeosporium ampelophagum* Pass |
| 4 | Botrytis rot | *Botrytis cinerea* Pers. |
| 5 | Grape vine leaf hopper | *Erythroneura* sps. |
| 6 | Grape vine thrips | *Phipiphorothrip scruentatus* Hord |
| 7 | Grape vine leaf roller | *Syllepta lunalis* Guenee |
| 8 | Grape vine beetle | *Sinosylon anale* Lens |
| 9 | Mealybugs | *Pscudococcus ficus* Sign. |

Among all these diseases downy mildew, powdery mildew and mealybug are major and causes great loss of the grape in Maharashtra.

### 1. Downy mildew:-

The disease caused by *Plasmopara viticola* (B. & C.) is found on grape vines in all parts of the world. The pathogen of this disease was native to North America prior to 1870s. Downy mildew is quite common in Maharashtra and south India particularly in Karnataka and Andhra Pradesh (Singh, 2005).

Downy mildew causes serious losses in humid parts of the world. The disease spread rapidly when temperature is below $15^0$ C and moisture is plenty. Low temperature and high humidity causes germination of sporangia to produce zoospores (Bilgrami and Dube, 1976).

A: Severe infection of downy mildew causing necrotic patches

B: Severe infection of downy mildew causing destruction of grape berries

Fig. 4 Effect of downy mildew infection

According to, Williams *et al.,* (2007 a), zoospore germination and host penetration occurred at 10 and 20°C and rarely at 30°C. High light frequency exerted an inhibitory effect on the development of zoospores soon after their release from sproangia (Williams *et al.,* 2007 b).

The pathogen *P viticola* infects all tender plants showing light green patches on the upper surface of the leaves and a whitish downy growth on the corresponding lower surface. These upper green patches turn yellow and chlorotic with age. The mildew growth covers the entire leaf blade, which turns brown and withers. The infections of the shoot cause water soaked lesions, on which downy growth of the fungus appears. Infected flowers die and drop off and fruit becomes grayish, the skin hardens and shrivels. Fruits are mummified and remaining attached to the bunch (Singh, 2005).

The downy mildew of grape is controlled by various cultural methods such as collection and burning of infected leaves. Plantation with proper spacing allows free air circulation and ensures low humidity that prevents rapid disease spread (Rangaswami and Mahadevan, 1999). Now days, various fungicides are used to control downy mildew infection such as, Bordeaux mixture, copper oxychloride, Zineb, Maneb, Mancozeb, Captan, Ridomil and phosphoric acid (Singh, 2005). There are some grape varieties which show resistance to downy mildew. Amber queen, Champion, Champa, Cardinal and Red Sultana are resistant varieties recommended to be used in our country. According to Kedge (2008), wild grape cultivars, Dodridge and Mango show total resistance to the downy mildew, while, Thompson seedless, $H_5$ Hybrid, Anab-E-Shahi and flame seedless are susceptible and cultivars Sonaka, Tas-E-Ganesh, Manikchaman, Sharad Sedless, Kalisahebi and Raosahebi were found highly susceptible.

Kedge (2008) studied effect of chemical elicitors in *in vitro* downy mildew control. Among all the treatment of chemicals such as $CuCl_3$, $K_2SO_4$, $KNO_3$, Salicylic acid and allopurinal, high disease control was observed in CuCl3, K2SO4 and $KNO_3$ (500ppm) concentration, while in salicylic acid and allopurinol, the optimum concentration was found to be 150 uM.

Cohen *et al.,* (1999) used a non-protein amino acid, BABA (DL-3 amino-n-butanoic acid, amino butyric acid) in leaf disc of susceptible grape cultivar by *in vitro* leaf disc method. This study show induced resistance in susceptible grape against downy mildew. Other five isomers of amino butyric acid did not give any protection against the downy mildew. According to Cohen (loc. cit.), resistance against downy mildew is may be due to accumulation of lignin like deposit in the host cells.

Kennelly *et al.,* (2005) studied seasonal development of ontogenic resistance to downy mildew in grape berries and rachises. The study revealed that lack of sporulation of pathogen *P. viticola* on early stage of berry development followed by conversion of functional stomata to lenticels during latency.

**Biological control of Downy mildew:-**

Cohen *et al.,* (2006) reported first the extracts of *Inula viscosa* control downy mildew of grapes caused by *Plamapara viticola.* The oil paste extracts of *Inula viscosa* leaves contains four highly effective compounds against the disease. Two major inhibitory compounds, each comprising 10.6% of the total paste weight, were identified as tomentosin and costic soda.

Post infection applications of microconidial suspensions of *Fusarium proliferatum* $G_6$ reduced sporangial production of *Plasmopara viticola* on grape leaf disks by 97% and prevented sporulation (Falk *et al.,* 1996). Microscopic examination of the hyphal interaction *in vitro* showed hyphae of *F. proliferatum* $G_6$ coiled around and inside sporangiophores of *P. viticola.* Applications of *F. proliferatum* $G_6$ microconidia reduced disease development on leaves and fruits clusters of *Vitis* intraspecific hybrid cultivars Chancellor and Lakemont.

Inhibition of sporulation and ultra structural alterations of grape vine downy mildew by endophytic fungus *Alternaria alternata* was studied by Musetti *et al.,* (2006). Cytological studies reveals that toxic action against *P. viticola* was due to three diketopiperazines:- cyclo (L-trans-4-hydroy-L-

proline), cyclo (L-leucine-phenylalanine-trans-4-hydroxy-L-proline) and cyclo (L-alanine-trans-4-hydroxy-L-proline).

**2) Powdery mildew:-**

This disease caused by *Uncinula necator* (Schw.) Burr. The disease is worldwide and occurs commonly in Europe, USA, parts of Africa and Australia in mild or severe form. In India it appears in epidemic form year after year, causing, great damage (Rangaswami and Mahadevan, 1999). It is common and destructive in Maharashtra, Gujrat, Tamilnadu and Andra Pradesh (Singh, 2005). Powdery mildew of grapevine is quite a serious disease of the crop as comparison to downy mildew.

The powdery mildew affects the leaves, stems, flowers and fruits, small whitish patches appear on both the surfaces of the young leaves. These patches enlarge, running together to cover large portions of the blade, covering the leaf surface with a characteristic, whitish powdary coating. The leaves turn grayish white as the disease advances; become dwarf, twisted and malformed. Infected stem becomes grey then dark brown. If the blossoms are affected, a grayish-white powdery growth appears on the floral parts and flowers drop. The entire inflorescence appears discolored and barren the affected berries become malformed and irregular, with grayish to dark brown patches on the skin. Often the skin cracks and the pulp are exposed if the berries are attacked when young. Their growth and development is arrested whereas if attacked when more than half mature, distortion and cracking of the skin results (Rangaswami and Mahadevan, 1999).

The fungus produces the cleistothecial or perfect stage only under certain climatic conditions and not in the plains in India, where grape is cultivated.

Rapid germination of conidia, infection and development of the pathogen takes place at 20°-30°C temperature and enough humidity, i.e. warm dry weather with sufficient humidity is very favourable for disease development Chavan and co-workers (1995) have reported that the temperature

in the range of $12.2^0$-$30.1^0$ C and relative humidity greater than 57.4% favours condia formation of *Uncinula necator* in Maharashtra.

The disease is controlled by cultural practices and some fungicides such as Sulfex, Wetasul, Bayleton, Saprol, Karathane, Topsin-M, Thiovit found effective against the disease. Cyprodinil and related anilopyrimidine fungicides are the latest ones recommended for use against powdery mildew of grape vines (Rangaswami and Mahadevan, 1999; Singh *et al.*, 2005)

Varieties of Red sultana, St-George and 1613 are resistant to powdary mildew. Flame muscat variety has been found resistant under the environmental conditions of Bangalore (Singh, 2005).

Recently, Rao *et al.,* (2007) reported 9 grape varieties, show resistance against powdary mildew, viz; Pearl of casaba, Victory, Cardinal, VP x Pox, Rubired, MA x RR 76-2 (Pusa Navrang) BA x BS-72-30, BA-BS-72-13 and AK-BS-71-28 were resistant.

However, Powdary Mildew of grape is controlled by following risk assessment index (RAI); in which temperature is important factor. RAI is based on disease pressure, pathogen status and spray schedule suggested for disease control (UC IPM: UC pest management Guidelines, 2006).

**Biological Controal:-**

Falk *et al.,* (1995) reported partial control of grape powdary mildew by mycoparasite *Ampelomyces quisqualis*. Two isolates of *A. quisqualis* ($G_5$ and $G_{273}$) were evaluated for pathogenicity and virulence against 18 monoconidial isolates of *Uncinula necator* on grape seedlings of cv. Riesling.

Control of powdary mildew in wild and cultivated grapes by Tydeid mite, *Orthotydeus lambi* was reported by English and co-worker (2005; 2007). They found that *O. lambi* can suppress the development of grape powdary mildew on *Vitis riparia*. However, similar reports were found about control of powdary mildew on cultivars Chardonny and Riesling by *O.lambi* (Melidossian *et al.,* 2005).

Crisp *et al.,* (2006 a), studied mode of action of milk and whey in the control of grape vine powdary mildew The study reveals that free radical production and the action of Lactoferrin (an antimicrobial component of milk) are associated with the control of powdary mildew by milk. An evaluation of biological and abiotic controls of grapevine powdary mildew was done in vine yard and greenhouse conditions (Crisp *et al.*, 2006 b). They found that application of *Bacillus substillis*, milk, whey canola-based oils and Ecocarb (potassium bicarbonate) all reduced the severity of powdary mildew to levels not significantly different from that on vines sprayed with sulphur.

**3. Mealybugs:-**

Mealybugs are common pest of grape vine. In India it is commonly found in all states where grape cultivation takes place. It requires low temperature with high humidity for development. Mealybug spread rapidly in the over-cast conditions. In Maharashtra mealybug is generally observed in the period of June to March (Atwal, 1976). Mealybug causes considerable loss in grape yield in the districts of Sangli and Satara.

Scientific name of grape mealybug is *Planococcus ficus* Sign. (Order-Hemiptera, Family- Pseudococcidae) It feeds on a wide range of host and has been cited in many grape-growing areas. This pest can reduce the vine vigour, lowers the quality of harvested grapes and affect the organoleptic features of the wine (Becerra *et al.,* 2006) *P. ficus* causes direct desiccation of bunches of wine grapes and unsightly honeydew excretion on bunches in the case of table grapes. High infestation of *P. ficus* can cause early leaf loss and resultant weakening of vines. Vine mealybug also vectors the vine leafroll virus (Walton and Pringle, 2004).

Mealybug are about 0.2 inch long, flat oval shaped and have a white waxy covering with wax filaments sticking out from circumference of the body. Longer filaments from posterior end look like "tails". Grape mealybugs dispauses in winter and has two generations in a year. Grape mealybug lay yellow to orange eggs within an egg sac under loose bark and in the cordons or

upper portions of the trunk. Egg hatches in June and in early winter season. Mature mealybug feed on leaves and fruits. Susceptibility to mealybug damage varies by variety. It is worse on shoot because the fruit often touches old wood. According to Sharma (2006), severity of grape mealybug was more in potassium deficient grape vine plants.

Mealybug damages grapes by contaminating clusters with cottony egg sac, larvae, adults and honeydew. Often honeydew is covered with a black sooty mold that inhibits photosynthesis in leaves (Bentley *et al.*, 2006).

Grape mealybug can be reduced by training vines so that clusters hang freely and do not touch the wood. Use of insecticides such as, Imidacloprid, Buprofezin, methomyl, Dimethoate etc. can reduce mealybug population effectively (Atwal, 1976).

**Biological control:-**

Parasitic wasps such as *Acerophagus hotativentis*, *Pseudophycus plavidulus*, *Leptomastix epona* and *Psedophycus angelieus* attack grape mealy bug. They play a prominent role in regulating mealybug population. The most effective mealybug predaor is a lady beetle called the mealybug destroyer, *Cryptoplaemus montrouzieri*. Another predator is *Cecidomyiid* flieds, feed on mealybug eggs and small larvae. These predators plus lace wings, minute pirate bugs and spiders are important in keeping mealybug population in check (Bentley *et al.*, 2006).

## B] Review of literature on *Agave* species

### 1. Introduction:-

*Agave cantala* (Roxb.) is commonly known as "Bombay aloe." In Maharashtra, it is called as "Ghaypat" or Ghayal." It is a leaf succulent and member of family Agavaceae, having major fibre yielding crops. *Agave cantala* (Roxb.) cultivated mainly as hedge plant and for production of fibres. Other species of Agavaceae viz., *Agave americana*, *A. sisalana*, *A.veracruz*, *A. fourcroydes*, *A. amaniensis*. *A. angustifolia*, etc., cultivated for fibre and serve as a hedge plants.

Most of *Agave* species can be cultivated in such areas which are unsuitable for other crops. *Agave* species are perennial in nature with a life span of 10-12 years. The plant is monocarpic i.e. flowering is followed by death. *Agave* reproduces mainly by vegetative propagation by bulbils and suckers.

*Agave* fibre is long, bold and strong fibre hence, it is used in preparation of various fibre materials such as, marine and industrial ropes, agricultural and commercial twines, other forms of cordage and cable, bags, sacs, carpets, fishing nets, rugs, various types of brushes and brooms, etc.

Besides these fibre productions, *Agave* species have some medicinal properties. It has some important phytochemicals which are used in preparation of medicines and other chemical products. In recent years, leaf extract of *Agave cantala* (Roxb.) is used as fungicide and insecticide in Sangli and Satara districts. Hence, it is very essential to have a brief knowledge of various aspects of this plant species.

### 2. History of *Agave*:-

According to, Chakravarty and Biswas (1986), Agaves are native of South and Central America from where these were introduced in large numbers to other countries. Tanzania, Kenya, Mozambique, Brazil, Angola, Madagascar are main *Agave* growing countries. Indonesia was major exporter of sisal fibre, prior to 1941, but now its fibre production is completely stopped

(Lock, 1969), South Africa, Comoro Islands, Uganda and Malawi in addition to Venezuela, Jamaica, Dominica and China are minor sisal growing countries, the countries like Morocco, Israel, Rhodesia, Congo Republic, Ghana, the Ivory Coast Republic, Trinidad, Mauritius, Papua and New Guinea where experimental planting of sisal has been tried. Sisal also exists in countries like, Libya, Western Australia, and Queens land, Burma, Malaysia, Fiji, Hawaii and India.

In India, Agaves were introduced by Portuguese in the 15$^{th}$ century. Now Agaves are completely naturalized in Indian soil as a hedge plants. It is observed that Agaves were growing scattered in different soils and in diverse climatic conditions (Chakravarty and Biswas, 1986).

## 3. Taxonomic position:-

Agaves were included in the family Agavaceae but formerly they were considered as a member of Liliaceae and then of Amaryllidaceae (dewit, 1965). Amaryllidaceae member have umbellate inflorescence, substended by an involucre of two or more (rarely one,) usually membranous bracts. But Agavaceae members have inflorescence in panicles and having fleshy leaves in rosette arrangement (dewit, 1965)

Some of the important species of genus *Agave* are as follows (Usher, 1971).

i) *Agave americana* L. (Century plant): Originated in Mexico, now widely cultivated as an ornamental plant in N. America, Africa and Europe.

ii) *A. atrovirens* Karw syn. *A. latissima* Jacobi: from Mexico.

iii) *A. cantala* (Haw). Roxb. (cantala): Cultivated in India. The fibre is used for cordage and is called Bombay Aloe fibre, Bombay Hemp, Cantala fibre.

iv) *A. complicata* trel : from Mexico.

v) *A. deserti* Engelm. : Cultivated in S.W.United states of America and N. Mexico.

vi) *A. falcata* Engelm: Mexico

Fig. 2 Habit: *Agave cantala* Roxb. with bulbil inside

vii) *A. fourcroydes* Lamaire (Hanequen *Agave*): Mexico.

viii) *A. funkiana* Koch & Bouche : Mexico

ix) *A. gracilispina* Engelm: mexico.

x) *A. heteracantha* Zucc. Syn. *A. lechuguilla* Torr. : United States of America, Mexico.

xi) *A. Kircheneriana* Berger.

xii) *A. lespinassei* Trel = *A. sapupe* Trel. (Zapupe Azul, Zapupe Estopier): Mexico.

xiii) *A. letonae* F.W. Taylor (letona): C. America.

xiv) *A. lophantha* Schiede : Mexico

xv) *A. mapisga* Trel.: Mexico

xvi) *A. melliflua* Trel.: Mexico

xvii) *A. palmazis* Trel. syn. *A. tequilana.* Weber (Chino, Azul, Mescal) : Mexico

xviii) *A. pesmulae* Trel. syn. *A. tequilana.* Weber syn. *A. pseudo-tequilana* Trel.

xix) *A. quiotifera* Trel. (Maguey ceniso): Mexico.

xx) *A. schotti* Engelm. (Amole): Arizona.

xxi) *A. sisalana* Perrine syn. *A. rigida* (Sisal Agave): Mexico

xxii) *A. utahensis* Engelm.: S.W. United States of America.

xxiii) *A. victoriae*-reginae Moore : S.E. United States of America.

xxiv) *A. virginica* L. (False Aloe): E. United State of America.

xxv) *X. weberi* cello. (Maguaey liso): Mexico.

**4. Distribution in India:-**

Agaves are distributed all over India. Agaves are introduced in India by Portuguese in 15$^{th}$ century. Now it is adapted to climatic conditions of India and growing predominantly in all states (Chakravarty and Biswas, 1986). In India, the species *Agave americana, A. amaniensis, A. angustifolia, A. cantala, A. fourcroydes, A. sisalana, A. veracruz* and *A. wightii* are found presently. According to Chakravarty and Biswas (), species *A.*

*sisalana*, *A. cantala* and *A. veracruz* having commercial importance than other *Agave* species. As the fibre requirement is concerned *A. sisalana* became more popular and spread throughout the country. *A. veracruz* is highly tolerant to moisture stress condition hence, it is grown in the drier belts of Andhra Pradesh and Maharashtra. *A. cantala* is distributed in states West Bengal, Bihar, Maharashtra and Orissa.

According to Chakravarty and Biswas (1986), the area under *Agave* plantation is more than 5,000 hectares in the country.

**Table No: 1.4 State wise areas under sisal plantation (Chakravarty and Biswas, loc. cit)**

| **State** | **Area** (in hectares) |
|---|---|
| Orissa | 2505 |
| Bihar | 280 |
| Andhra Pradesh | 752 |
| West Bengal | 560 |
| Maharashtra | 726 |
| Madhya Pradesh | 147 |
| Karnataka | 84 |
| Total | 5054 |

Annual production of *Agave* fibre in India is about 3000 tonnes but the requirement of country is 16000 tonnes as assessed by different committies (Chakravarty and Biswas 1986). There is a need to paid attention on yield and more plantations.

## 5. Morphology:-

*Agave* is a large genus of short stemed, half woody plants, bearing a rosette of leaves. Most agaves are devoid of stems and bear their leaf rosettes close to the ground. Thus the agaves are the plants which appear to consist of nothing more than a cluster or whorl of leaves springing from ground level like a rosette. The leaves are however, crowded densely around a thick sappy stem,

which is short, single and unbranched and is completely hidden by the leaves (Aiyer, 1966).

The leaves are thick, fleshy, long, and narrow with a spiny tip and often a more or less spiny margin. The leaves are flat or with a deep central groove running on the upper surface from base to apex. The leaves are very strong, and are from about 90-150 cm. or even 180 cm long and about 10-15 cm wide. The width is more or less uniform throughout and narrows only towards the pointed tip. The leaves are smooth and glaucous, a green or bluish with an ashy grey bloom on the surface (Aiyer, 1966).

The *Agave* plant flowers only once in its life time and dies, not after 100 years, as its popular name of "century plants" implies; but after only 10-15 years (i.e. monocorpic). Once the inflorescence appears, the rosettes stop growing, to wither completely after fruit formation. However, many agaves form secondary rosettes at the base or on runners (dewit, 1965).

Aiyer (1966) stated that the flowering stem arises from the centre of the plant in the form of a thick pole, which rapidly grows to a height of 6-9m. The flowers are borne on a pole like scepe in fascicles. The perianth is 6- lobed and funnel shaped, the stamens are 6 in number, the stigma is 3- lobed and the ovary is 3- celled and inferior. Fruits are normally formed and contain numerous black flattened seeds. Frequently, however, floral buds get developed into bulbils or plantlets.

## 6. Propagation and planting:-

i) Propagation: *Agave* are propagated mainly by vegetatively but very rarely by means of seed germination.

a) Suckers: Mature *Agave* plants produce root suckers from about their third year and continue to do so for 2 to 3 years. Each *Agave* plant yields some 20 suckers in this period (Aiyer, 1966).

b) Bulbils: At the *Agave* of 10-12 years, *Agave* begins to flower. The flower stalk called pole is stout and mast like structure measuring about 12-15 cm in diameter at the base and about 6-9 m in height. The pole produces lateral

branches developing bunches of "bulbils" or "small plantlets" which can be removed and used as planting material (Aiyer, 1966). The bulbils are very small, being only about 5-15 cm in height. After flowering, parent plant dies down.

c) Seedlings: There are very few cases of propagation of Agaves by means of seeds producing seedlings. Establishment of seedlings of *Agave desrti* in the Sonoran desert is a rare event. According to Gentry (1972) and Nobel (1977), only one seed in 1.2 million apparently leads to a mature plant and young seedlings are difficult to find hence, survival of seedlings of *A.deserti* required unusual wet years and the protection afforded by nurse plants or other shelters and water stress in the seedling stage may be the most important factors affecting establishment (Jordan and Nobel, 1979).

A procedure for rapid propagation of *Agave* species (*Agave cantala* Roxb., *A. fourcroydes* Lem. and *A. sisalana* Perrine) have been developed by Binh *et al.*, (1990). The explants were excised from stolon plantlets, sterilized and cultivated on Murashige and Skoog (MS) basal medium containing 2% sucrose, 10% coconut water and 0.8% agar. The addition of following combination of growth substances std. 0.075 mg. 1-1 naphthalenacetic acid (NAA) + 0.1 mg 1-1 indolylbutaric acid (IBA) + 0.5mg 1-1 kinetin (KIN) caused an extensive proliferation of multiple shoot primordia. Subcultres of these on the same medium were successful for the multiplication with an index of 3-4 times per 4 weeks subculture period. Shoots were rooted on hormone free MS medium and then transferred into a sand bed for acclimation before field planting.

ii) Planting:-

Agaves are cultivated as indoor ornaments including A. Americana. In India species like *A. cantala*, *A. sisalana* and *A. veracruz* are planted along railway embankments and road sides. These plants are suitable for hedging and fencing. They are also planted for checking soil erosion along hill slope.

In nursery, suckers and bulbils are planted for a year before they are put down in plantation. Mostly bulbils are preferred for planting because the plants obtained from bulbils give more yield than that of suckers.

## 7. Factors influencing growth of Agaves:-

### a) Rain fall:

Agaves are leaf succulents and they can withstand droughts but it is not true that Agaves requires low rain fall. Species like *A. sisalana* respond to optimum rain fall between 1,200 to 1,800 mm (50 to 70 inch). But it can grow where the rain fall is less than 760 mm (30 inch). Low rain fall causes decrease in annual fibre yield. If rain fall exceeds up to 2,000 mm (80 inch), it causes water logging of soils and prevents proper root formation and consequently, the plants are stunted.

### b) Temperature:-

Maximum temperature ranges between $27^0$C to $32^0$C and minimum not less than $16^0$C is favorable for *Agave*. The diurnal range should not be more than 70 to $10^0$ C. Agaves can tolerate low and high atmospheric temperature but resulted into slow growth. Hence, the life cycle of the *Agave* is usually prolonged.

### c) Light:

Plenty of light and strong sunshine are favorable for growth of a Agaves. Low light cause fine, weak and poor fibre content. However, day length in not considered to have much effect upon sisal.

### d) Soil:

Agaves can grow well in friable and draining soils. However, Agaves are tolerant to wide variety of soils which is neither too acidic nor low in nutrients, is best for Agaves. The increase in soil salinity can reduce the fresh and dry weights of the shoot in *Agave sisalana* (El-Gamassy *et al.*, 1974).

**8. Economic importance of *Agave* species:-**

**i) Fibres: -** The fibres of *Agave* are obtained from leaves. The Agaves fibre is one of the important hard fibres. The most economically important fibre sisal hemp is obtained from the leaves of *Agave sisalana* (dewit, 1965). Other species of *Agave* yielding fibre are, *Agave americana, A. cantala, A. falcate, A. fourcroydes, A. funkiana, A. gracilispina, A. lechuguilla, A. kircheneriana, A. letonae, A. lophantha, A. victoriae- reginae, A. zapupe*, etc. (Usher 1971).

The *Agave* fibre is used in manufacturing of binder twine, marine and industrial rope, door sags, bags, sacks, soles for sandals, cordage, cable, carpets, fishing nets, hammocks and various types of brushes and brooms. It is also used in the manufacture of flag and corrugated polyester sheets reinforced which is stronger and cheaper than the comparable sheets of other materials.

**ii) Food:-** The leaf bass of *Agave deserti* and *A. utahenis* are roasted and eaten by local Indians, similarly the flower stalks are chewed like sugarcane (Usher, 1971). The inner stem of Agaves is edible (Aiyer, 1966). During the famine the poor people boil and eat it.

**iii) Alcoholic beverages:-** Various alcoholic beverage are prepared from leaves flower and stem of *Agave* species. According to Usher (1971), "Mescal" is distilled from fermented stems and leaf bases of *Agave atrovirens A. kircheneriana, A tequilana* etc. "Tequila" is obtained from *A. tequilana* (Kluge and Tinge, 1978) "Aquamiel" is made from the juice of flower stalks of *A. complicata. A weberi* and *A quiotifera.* "Pulque" is *A. lehmanni* (dewit 1965), *A. gracilispina, A. mapisaga* (Usher, 1971) and *A. complicata.*

**iv) Medicinal importance: -**

At the time of the Spanish conquest of America, the Artec and Maya people were skilled in wound healing. They use *Agave* sap (often with egg-white) to bind powder or gums in pastes or poultices to be applied to wounds A treatise of 1552 describes an Artec treatment for diarrhea and dysentery with Agave juice, combined with freshly ground *Zea meys* (maize) and extract of *Utricularia* spp. (bladderwort) was given as an enema (Khare, 2003).

Mexican alcoholic drinks, both tequila and mescal, are distilled from the fermented sap or juice of Agaves (alcohol contents 3-4 %) These were used by Mexican people to treat nervous conditions (Khare, 2003).

The root possesses diuretic properties, sap laxative, diuretic, emmenagogue and antiscorbutic. Fresh juice of leaves is used externally for bruises and contusions and for its antiseptic and anti-inflammatory properties (Peana *et al.*, 1997).

*Agave sisalana*, cultivated in sub- tropical America and Kenya, is a source of hecogenin in the manufacturing of corticosteroids.

*Agave* is considered demulcent, laxative and antiseptic. The sap is a soothing remedy for many digestive ailments. It is used to treat ulcers and inflammatory conditions affecting the stomach and intestines and protects them from infection and irritation, encourages healing. *Agave* is also employed to treat liver diseases (Khare, 2003).

In American folk medicine, *Agave* is used for spasm, coughs, accumulated phlegm, poor urination kidney inflammation and pain, urinary tract infection, wounds.

Tincture of *Agave americana* is used in homoeopathy and is indicated in constipation, poor apetite scurvey, stranguary, swollen and bleeding gums; legs covered with dark, purple blotches, swollen, painful and hard.

**9. Phytochemical studies:-**

Chen and Liang (1976) isolated and identified steroidal sapogenins from five *Agave* species, *A. americana*, *A. sisalana*, *A.cantala*, *A. angustifolia* and a variety of *A. americana*. Hecogenin, the valuable raw material for commercial production of steroid hormones, was found in all the samples tested. Beta sitosterol, neotigogenin, hecogenin gitogenin, chlorogenin from the leaves of *A. angustifolia* and tigogenin, betasitosterol, tigogenin, hecogenin, g-dehydrohecogenin schlorogenin and hainangenin from the leaves of a variety of *A. americana.*

According to Varshney *et al.*, (1981), the leaves of *A. cantala* yielded a new steroidal saponin named Cantalanin-A, which is a glycoside of hecogenin with 2 glucose molecules. Also the fruits of *A.cantala* contain a steroidal saponin which is a glycoside of hecogenin with 3 molecules of glucose (Varshney *et al.*, 1982). A new steroidal saponin was isolated by Sharma and Sati (1982) from the ethanolic extract of the root of *A. cantala.* Sati *et al.,* (1985), isolated cantalasaponin-1, a novel (antineoplastic) spirostanol bisdesmoside from the methanolic extract of rhizomes of *A. cantala.* Three spirostanol glycosides, cantalasaponin -2, - 4 and -3 were isolated from the methanolic extract of the rhizomes of *A. cantala* (Sati *et al.,* 1986; Pant *et al.,* 1986). Three spirostanol glycosides, cantalasaponin 6 - 8 were isolated by Pant *et al.,* (1987) from the methoanolic extract of the leaves of *A. cantala.*

Jain (1987) isolated a new steroidal saponin from the aerial part of *A. cantala.* Uniyal *et al.* (1990) isolated two new steroidal glycosides agaveside A and B from the fruits of *A. cantala.* A new molluscicidal spirostanol glycoside was isolated by Kishor (1990) from the ethanolic extract of the inflorescence of *A. cantala.* Steroidal glycoside, agaveside isolated by Uniyal *et al.,* (1991 a & b), from the fruits of *A. cantala.* Agaveside C and D isolated from the fruits of *A. cantala.* Molluscicidal steroidal glycoside isolated by Rana (1993) from inflorescence of *A. cantala.* Gbolade (1988) studied the hecogenin content in incubated *Agave americana* and *Furcrea selloa-marginata.* Agamanone, a flavonone from *A. americana* was isolated for the first time by Parmar *et al.,* (1992). A new bisdesmosidic spirostanol saponin along with three saponins, were isolated by Yokosuku *et al.,* (2000) from *A. americana.* Jin *et al.,* (2002 a) isolated a new steroidal saponin and two know steroidal compounds from fermented leaves of *A. americana.* Jin *et al.,* (2002 b) isolated 3 new steroidal glycoside from fermented leaves of *Agave americana.* Among 3 compounds, one new compound is agamenoside C.

Jin *et al.*, (2004) isolated three new steroidal saponins named agamenosides H-J (1-3) and a new cholestane steroid agavegenin D (4) from the waste residue of fibre separation from *A. americana* leaves. Tinto *et al.*,

(2005) isolated a new homoisoflavanoid from *A. americana* and *Agave barbadensis*.

**10. Molluscicidal, spermicidal, and antifungal properties of *Agave*:-**

Some Agave spp. has molluscicidal, spermicidal and antifungal properties as below:

i) According to Pant *et al.*, (1986), cantalasaponi -1 was found to be lethal against *Biomphalaria glabrata*, the snail vector of the disease schistosomiasis, at a concentration of 7 ppm. However, Cantalasaponi-7 isolated from methanolic extract of leaves of *A. cantala* (Pant *et al.*, 1987) displayed weak activity towards *Biomphalaria glabrata.*

ii) According to Pant (1988), ethanol extract of *A. cantala* rhizomes and its spirostanol constituents were shown to possess spermicidal activity.

iii) Molluscicidal spirostanol glycoside has been isolated by Kishor (1990) from the ethanolic extract of the inflorescence of *A. cantala.*

iv) Acetone extract of *A. cantala* leaf shows growth regulating activity on diamondback moth *Plutella xylostella* (L) of cabbage (Reddy and Urs, 1991) cabbage leaves were treated with acetone extract of *A. cantala* leaf at the concentration of 60 mg/ml, show prolonged larval and pupal periods, decreased percentage of adult emergence and adult longevity, reduced egg hatchability.

v) Rana (1993) isolated a new molluscicidal steroid glycoside from the inflorescence of *A. cantala.*

vi) Dharmshaktu *et al.* (1987) studied the mosquito larvicidal properties of leaf and seed extract of *A. americana* in laboratory. Leaf extract tested against three mosquito species led to 100% mortality of $4^{th}$ stage of Anopheles, Aedes and culex larvae at concentration of 0.08% within 24-48 h, whereas 100% mortality of stage 1 larvae

occurred at lower concentration: 0.0032% for *Aedes aegepti*, 0.016% for *Culex quinquefasciatus* and 0.08% for *Anopheles stephensi*.

vii) The boiled water extract of *Agave decepiens* and *A. americana* show molluscicidal action against adult *Biomphalaria alexandrina*, *B. truncates* and *Lymnaea cailliaudi* (Shoeb *et al.*, 1986).

viii) According to Reddy and Reddy (1987) *A. americana* show antifungal activity against *Drechslera spicifera* (Bain) Nicot. and *Fusarium solani* (Mart) App and Wollenw. Leaf extract of *A. americana* show total spore germination inhibition of *F. solani* and partial spore germination inhibition of *D. spicifera*.

ix) The larvicidal properties of *A. americana* was reported by Consoli *et al.*, (1988) against *Aedes fluviatilis* (Lutz) at 100 ppm.

x) Parmar *et al.*, (1992) reported antibacterial tetratriacontanol derivatives from *A. americana*.

xi) Leaf extract *of A. americana* show molluscicidal properties against eggs and adult of three species of freshwater snails, *Indoplanorbis exustus*, *Lymnaea luteola* and *Gyraulus convexiusculus* and haemolytic activity with sheep red blood cells (Sukumaran *et al.*, 1994).

xii) Sharma (1998) reported antifungal properties of plant extract of *A. americana* against causal fungi of yellow and rhizome rot of ginger. The extract was found effective in reducing mycelial growth of *Fusarium oxysporum* and *Pythium aphanidermatum*.

xiii) Bin (2003) found that the powder of *A. americana* leaves (30g / kg grains) can reduce the weight loss and the emergence of bruchid beetle (*Acanthoscellides obtectus*) in bean storages.

## C] Side-effects of chemical pesticides on plants:-

The population of the world has been increasing threateningly. The world's population is expected to reach nine million in 2050 (Torti *et al.*, 2006). The continuous decline in soil and water sources and increasing population of the world, several methods are used to increase agricultural production. But various factors such as climatic condition, diseases and pests cause severe crop losses (Oerke, 1994). It is estimated that crop losses caused by diseases is about 12% of the total production, which is worth 42- billion dollars (Kazan and Gurel, 2001). One of the methods used to deal with agricultural problems is the use of pesticides.

In spite of unquestionable benefits of pesticides, their uncontrolled overuse negatively affects other untargeted living organisms, including human beings (Comeleko lu and Mazamnc, 2001). The side-effects of DDT on environment were first described by Rachel Carson in 1962 in "Silent Spring". It is a known fact that widespread use of pesticides lead to a series of toxicological and environmental problems such as prolonged existence of some pesticides in the environments without breaking down and the evolution of more resistant species of harmful organisms (Suwalsky *et al.*, 2000).

Pesticides used in appropriate doses recommended by the producers, do not normally lead to negative effect, but they may have some positive effect on the development of plants. But if they are given in overdoses cause phytotoxic effects and lead to anatomical and morphological deformities causes decrease in productivity. Pesticides cause biotic stress in plants (Lewitt, 1980).

Field crops grown in pesticide treated soils may contain measurable amounts of pesticides in the top portion of the plant. Translocation of chemical hydrocarbons insecticides in food crops has been studies extensively (Lichtenstein, 1650, 1960; Lichtenstein and Schulz, 1960, 1965; Lichtenstein *et al.*, 1965). Most such studies were conducted with cucumbers (*Cucumis sativus*) (Lichtenstein, 1960), lettuce (*Lectuca sativa*) (Licthenstiein 1960), alfalfa (Medicago *sativa* L.) (King *et al.*, 1966; Zins *et al.*, 1991), canola

(*Brassica napus* L.) (Dupont and Khan, 1993), and soybeans (*Glycine max*) (Bruce and Decker, 1966).

Toxicants first affect the most sensitive photosynthetic parts of a plant and then the enzymatic systems (Korte *et al.,* 2000). Azinphosmethyl and organophosphorus pesticides, was used on *Medicago sativa* L. plant and it was seen that 24 hours after the application, chlorophyll constituents was decrease more as compared to the control group (Flocco *et al.,* 2003). The application of high concentrated chemical preparations leads to stresses is the increase in the synthesis of specific peptides and proteins (Przymusi_ski, 2004). Most plant produce stress proteins in order to protect themselves from stress conditions. There are lot of studies suggesting that pesticide application increase protein synthesis and lead to the formation of stress proteins (Scarponi *et al.*; Saladin *et al.*, 2003).

The residue of $_{14}$C-DDT was reported by Nash *et al.* (1970) in soybeans and cotton (*Gossypium hirsutam* L.). The effects of DDT on the germination and growth of various plants were studied by Mitra and Raghu (1989). They found that, oil rich seeds of plants, such as pea nut (*Arachis hypogaea*) and mustard (*Brassica juncea*), were more prone to DDT induced inhibition of germination and subsequent plant growth than cereals, pulses and fibre crops, like rice (*Oryza sativa*), mungbean (*Vigna radiata*) and cotton (*Gossypium hirsutam*). It is suggested that lipids of the plant cell solubilize and disperse DDT in the cytoplasm, which in turn, affects normal metabolism within the cell (Mitra and Raghu, 1989). Verma and Pillai (1991) studied bioavailability of soil-bound residues of DDT and HCH to green gram (*Cier arietinum*), maize (Zea meys) and dry land rice (*Oryza sativa*). They found that binding of DDT was more in the shoots and that of HCH in roots. Residue of DDT was reported in cowpea (*Vigna* sp.) by Kiflom *et al.,* (1999).

Mani and Jayraj (1976) reported that the insecticides monocrotophos and phosphamidon likewise increased concentrations of nitrogen and phosphorous in rice plants; these changes were thought to contribute to a resurgence in numbers of the rice blue leafhopper. Pesticide can alter the

chemical composition of plants. The changes that occur appear to be specific for both the plant and the pesticides involved. For example, certain organochlorine insecticides have increased the amounts of some macro- and micro-element constituents (Al, B, Ca, Cu, Fe, K, Mg, Mn, N,P, Sr, and Zn) of corn and beans, decreased the amounts of others (Cole *et al.,* 1968). In another study, DDT, aldrin, endrin and lindane were found to stimulate synthesis of the important amino acids arginine, histidine, leucine, lysine, praline and tyrosine in crop but decreased the content of tryptophane (Thakre and Saxena, 1972). According to Rouchand *et al.,* (1983) soil treatment to carrot with insecticides Nexion, Birlane and Dyfonate increased the concentration of free sugars in roots.

There are many reports of adverse effect of fungicides on plants. Nowadays many modern systematic fungicides are extensively used in agriculture. According Reyes (1975), the application of benlate, a fungicide, produced chlorosis and irregular depression at the central and marginal portion of saffron leaves. Alcholor metalaxyl induced sharp decreases in cell division (Coman *et al.,* 1975). John and co-workers (1975) reported that Triarimol inhibits the seedling growth of pea. Siddiqui and Ahmed (2002) studied effects of systematic fungicides on protein, carbohydrate, amino acids and phenolic contents of susceptible (Maxipak) and resistant (Povan) varieties of *Triticum aestivum* L. They found that application of systematic fungicide caused a significant decrease in total protein and carbohydrate content compared to the control. An osmotic shock effect of systematic fungicides results in the release of protein and loss of membrane transport ability in the leaf cells (Amar and Reinhold, 1973). It has been suggested that the toxicant produced by the application of systematic fungicides inhibits protein synthesis by the binding the larger ribosomal subunits inducing change enzyme system (Person *et al.,* 1975) ceasing ATP and NADP formation (Mishra and Waywood, 1968; Siddiqui, 1997). It has been reported that plants treated with fungicides suffer from chemical stress (Siddiqui *et al.,* 1997). The toxicant produced by the application of systematic fungicide inhibits respiration photosynthesis and

protein synthesis by inhibiting activity NADH cytochrome "c" oxidases in the respiratory chain and accumulation of succinate and blocking of alternative pathway of respiration (Berger and Cwick, 1990; Pillonel, 1993). The extensive use of fungicides on pear, apple and raspberry trees during their flowering periods has negative effects on pollen germination and fruit formation (Redalen, 1980; Fell *et al.,* 1983; Marcucci and Filiti, 1984). Higher concentrations of Topsin M systematic fungicide have harmful effects on *Vigna radiata* l. Wilezek and *Pennisetum americanum* L. It is more effective on root growth than on stem growth (Siddiqui *et al.*, 1999b; Siddiqui and Khan, 2001). According to Siddiqui *et al.,* (1999a), Beniate, a systematic fungicide, blocked root growth. It has also seen that root dry weights decreased especially after higher concentrations of phosphate fungicide were applied to *Cormbia calophylla* and *Banksia brownii* plants (Barrett *et al.,* 2003).

Tort and Turkyilmazi (2003) found that recommended dose and two-fold of recommended dose of Captan fungicide increased the amounts of proline in pepper. Saladin *et al.,* (2003 a) reported that the application of fludioxionil and primethanil fungicides under chemical control of *Botrytis cinerea* to a vine plant (*Vitis vinifera* L.) encouraged protein synthesis. It was also reported that as a result of breakdown of structural proteins, fungicide applications might result in a decrease in the amounts of protein (Goicoecha *et al.,* 2000; Pinheiro *et al.,* 2001). Saladin *et al.*, (2003b) studied effects of fludioxonil and pyrimethanil, used against *Botrytis cinerea*, on carbohydrate physiology in *Vitis vinifera* L. They found that *in vitro* both fungicides decreased gas exchanges, photosynthetic pigment and starch concentration in the leaves, whereas soluble carbohydrates transiently accumulated, suggesting that plantlets mobilized starch in response to photosynthesis inhibition caused by fungicides.

Tort *et al.,* (2006) studied morphological and physiological effects of a fungicide with a thiram agent on some corn culture forms. They found that application of fungicide cause decrease in root coleoptile length, root-stem length, fresh and dry weights as compared to the controls. Photosynthetic

pigments substances decreased in cin cultivar but increased in sert cultivar of corn. According to them, high concentration of fungicides affects plant metabolism of both cultivars negatively by causing biotic stress.

Spray adjuvants assist in the penetration of pesticides through plant surface. Spray adjuvants allow better coverage and penetration of pesticides and are used extensively in viticultural spray programs. However, spray adjuvant disrupt the cuticular layer that covers the plant surface. Mlikota Gabler *et al.*, (2003) reported that fungal infection is more likely to occur with decreased cuticular thickness, or with an increased number of entry points through the cuticle. Therefore, even though adjuvant is used to increase the efficacy of a fungicide, it increases the susceptibility to other pathogens that were not a target of that fungicide (Rogiers *et al.,* in press). Adjuvant also alter the natural microflora on plant tissues through changes in the immediate physical and chemical environment. Some of the indigenous yeast, fungal and bacterial species are beneficial in that they deter the growth of pathogens (Blakeman and Fokkema, 1982). Rogier *et al.,* (in press) found that spray adjuvant disrupt wax plate lets of grape berry and increases the susceptibility of *Botrytis cinerea*. They also found that spray adjuvant in some circumstances reduce the indigenous microflora on the berry's surface.

In developing countries, like India the area under grape cultivation increasing rapidly. Pesticides exposure represents a major health hazard for sprayers in grape garden. Major chemical groups of pesticide used in grape gardens are organophosphate, carbonate, organochlorines, nitro and chlorophenols and pyridyl derivatives (Dave, 1998) It has been observed that maximum exposures occur while mixing and handling of the concentrated solutions. The biochemical effects produced by certain pesticides can be enzyme induction or enzyme inhibition organophosphorus and carbamate are widely used pesticides in grape gardens. These are inhibitor of enzyme cholinesterase (WHO, 1992 and 1993). According to WHO (1993 and 1994), the workers exposed to the organophosphorus pesticide alone or in combination with organochlorine, altered liver enzyme activities observed in them. Patil and

co-workers (2003) studied biochemical effects of various pesticides on sprayers of grape gardens they found that the long term exposure of various pesticides on sprayers of grape garden affect liver, heme biosynthesis and decrease in serum cholinesterase.

The above information gives idea regarding role of chemical pesticides and other substances creating the side effects on consumers as well as changing quality, teste, durability and the food value of fruits and other edible parts of different cultivated crops.