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GRAPE GROWING

IN THE

NASIK DISTRICT

BY

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Nasik.

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Vine Leaf showing Powdery Mildew.

(See Page 17.)

PREFACE.

Mr. H. V. Gole has made a special study of grape growing on his own lands at Nasik. He has been of great assistance to the Agricultural Department in putting his plantations at their disposal for spraying experiments. He has also done a great deal to encourage the practice of spraying against mildew among the grape growers of Nasik.

It is gratifying that he has been able to record his impressions of grape growing in the Nasik District with suggestions for its improvement. We have by no means reached the last stage of progress in grape growing. Mr. Gole's bulletin marks one step in advance. This present bulletin is a record of the ideas of an actual grower, and as such is deserving of attention by other growers and by all students of fruit culture.

February 24, 1915.

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GRAPE-GROWING
IN THE ~~NORTH~~ Nasik DISTRICT.

1. *Preliminary Remarks.*

The grape is probably the earliest cultivated fruit. Its cultivation has followed in the wake of civilization. The word Draksha and Draksharasa (grape and grape-wine) occur in Sanskrit literature indicating that the Aryans grew grapes and pressed the fruit for wine. It was much cultivated by the early Romans. The vine is much prized on account of its fruit for dessert purposes and for the excellent wines made from it. Here in India, we are not, at present, concerned with vintage or wine-making. Zealous lovers of the grape may assert that the grape wine is the most wholesome of all stimulants, a gift of God to man. It is a far cry from palm-toddy to grape-wine. A discussion on such a controversial question is of little practical use here. The grape is not grown extensively and the industry is still in its infancy. The fruit is much relished for the table and there is an ever-growing demand for it. Even this demand is not adequately met and the local output has to be supplemented by imports from Malta. At present there are two important centres where the grape is considerably grown—*viz.*, Quetta and Nasik. Modest attempts are made to grow it in Poona and Satara Districts. At one time Kanad and Aurangabad (in Hyderabad State, Deccan) were famous for the excellent grapes grown there.

In such a vast variety of soil and climate as is met with in the Indian Peninsula it is possible to get the fruit almost all the year round by careful cultivation of the grape in suitable locations. People are now getting interested in its cultivation and we may hope that a considerable advance will be made in a few years more. The object of this pamphlet is to supply some detailed information on grape growing to those who may wish to take up its cultivation.

2. *Soil and Climate.*

As to the quality of the soil it may be said that any land which will grow fair grain is rich enough for grapes. That the soil should be naturally very rich is not so important as that it should be loose and friable, so that the roots of the vine can penetrate it easily and draw nourishment as well as moisture from below. The best results may be obtained on a soil which is naturally porous so that it will drain easily and retain moisture on the surface. Light medium black soil with a porous subsoil of soft murum or lime is generally suitable for grapes. I do not, however, think that a very poor soil can be depended upon to produce grapes; and the same may be said of a soil which is too rich. On the whole, therefore, a soil of medium fertility with a porous subsoil will be generally found to give good results.

The grape-vine will not thrive in situations where the rainfall is heavy. It does remarkably well at Nasik where the average rainfall is 28·98 inches. I doubt if the grape can be successfully grown where the rainfall exceeds 35 or 40 inches. However the grape-vine has shown such a remarkable adaptability to climatic conditions that it is not safe to dogmatize.

3. *Varieties.*

There are five or six species of *Vitis*, the generic name of the grape. The different species have many varieties belonging to each. The varieties are too numerous to mention here. Their number is probably more than 150. The varieties to be met with in India all belong to the species *Vinifera*. They are classed according to the colour of the fruit. The following are varieties with which I am acquainted :—

Black.

(1) Hafsi or Kali (Synonym, probably Black Morocco) : Vines very vigorous growers but shy bearers ; leaves deeply lobed and of bright green colour ; bunches heavily shouldered, large, irregular ; berries large, ovoid-oblong, slightly broad at the base and depressed at the apex.

(2) Neela (Synonym, probably Miller's Burgundy): Vines vigorous growers ; leaves large and entire, deeply serrated and pubescent appearing as if dusted over with flour ; bunches medium ; berries medium, oval, black with a purple bloom.

(3) Karwandee (Black Prince), bunches small, shouldered, tapering ; berries small, round, dark in colour when fully ripe. The variety is very prolific, but the quality of the fruit is not very rich. All the berries do not ripen at the same time.

White.

(4) Sahibee (Synonym, probably Decon's Superb) : Vines very vigorous growers, but bear modestly ; dark green leaves, lobed, rough and leathery to touch ; bunches large and handsome ; berries narrow at the base and broad towards the apex, and amber coloured. This is splendid looking grape of very rich quality.

(5) Fakari (Synonym, probably Muskat of Alexandria) : Leaves bright green and soft to the touch ; bunches handsome and well formed and large ; berries broad at base and narrow at apex and amber coloured, musky and sweet ; unquestionably one of the finest grapes in cultivation in India.

(6) Khismishi or seedless variety : This is not found at Nasik but is grown at Quetta. The berries are greenish white and seedless.

(7) Red-coloured Bhokari or Abi : This is by far the commonest variety grown at Nasik. The vines grow well and bear abundantly. The leaves are dark green, lobed and serrated. The bunches are medium shouldered and tapering ; berries medium, round and assume a reddish bloom when fully ripe.

(8) Gosavi : A very inferior variety not much grown. The fruit does not set readily.

I have obtained two varieties from Karachi, but they have not as yet borne fruit.

Bhokari bears abundantly and is in much favour. Sahibee and Fakari are very superior varieties yielding rich fruit, but they bear modestly. They may be planted in small plots which may accommodate 200 vines. It may be that by changing the system of training and pruning, or by grafting, these varieties may be made to bear fairly well.

As a rule different varieties should not be mixed and planted together in one plot, as they may demand different cultural treatment.

4. *Propagation.*

The vine is a plant of most simple and easy propagation, the roots being freely and readily produced from every portion of the stem when placed in favourable conditions. Thus it is that propagation is chiefly done by means of cuttings. The vine can also be propagated from seeds, by layering and by grafting.

Propagation by seeds.—It is a tedious task to grow vines from seeds, requiring three or four years before the plants come to bearing. The raising of the vine from seed is thus more a labour of love than of actual profit. Nevertheless, it has certain advantages. By cutting, grafting or layering the same variety is perpetuated without the slightest deviation from the parent. Not so with seedlings; by natural or spontaneous variation seedlings occasionally give new varieties which may prove valuable. In fact, many a new variety has been added to the existing number by the patient labours of zealous lovers of the grape, who raised vines from seeds after hybridizing.

Propagation by cuttings.—The cuttings are usually taken in October when the vines are pruned for fruit. Strong healthy growth of one season, that is, growth after the April pruning, with ripe wood is chosen. The lower cut should be just below a node (*i.e.*, site of a leaf or leaf-scar), the upper a little above. The cuttings are 9″ to 11″ long with four to six well formed buds. They should be immersed in water for 12 to 24 hours before they are set to root in well prepared beds. The beds should be four feet wide with a distance of 18″ between so that a man can go round and do the weeding easily. Cuttings are planted in pairs. They are planted in furrows 9″ apart, the distance between the pairs being 6″. A furrow is opened in the bed and the cuttings are placed in it. The earth from the next furrow is then thrown in the furrow in front to cover the cutting so that only two or three buds or eyes may show above ground. The earth is then firmly pressed by the foot round the cuttings. The same operation should be performed for every furrow. After planting, the bed should receive a good watering and it should be watered every 4th or 5th day afterwards. In 4 or 5 weeks the buds will have made a start after which water should be given every 6th or 7th day. If any weeds make their appearance they should be gently removed, taking care to leave the cuttings undisturbed. By the end of December the cuttings will have developed slender roots and new growth 5″ to 6″ in length. They are then transplanted in January. This mode of propagation is not very difficult or troublesome. Nearly 70 to 80 per cent. of the cuttings strike root and they may be transplanted safely. The cost of this kind of propagation is small. The pruned portions are thrown away or burned. The cuttings are generally sold at one rupee a thousand pairs. This represents not the price of the wood, but merely the labour charge. The cuttings will retain their vitality for a week or even a fortnight or more (with due care) and thus they may be safely sent by post or by railway parcel.

I have described above the one method usually followed at Nasik. It is not absolutely necessary to take the cuttings in October. I obtained some cuttings of new varieties in February. They rooted without difficulty, and were transplanted, some in August and some in September. I have also tried cuttings in April and they rooted fairly well. I consider it a better plan to grow cuttings in the nursery for six months or even one year before they are transplanted and thus allow the growth of strong healthy roots. In transplanting, the young growth on the cuttings should be cut back to two

or three buds, the roots should also be pruned a little. When this method is followed the vines will make a good start and give one or two healthy canes which may bear fruit the same year. Of course if this method is followed the distance between the furrows in the nursery should be 18" and the cuttings should be placed one foot apart in the furrows. However, this is not the practice at present and it will be long before the advantages of it are demonstrated and brought home to the growers.

Grafting.—The roots of *Vitis vinifera* are very succeptible to the ravages of the Phylloxera insect. Other species like *Vitis riparia* of American origin are very resistant to the attacks of Phylloxera. Advantage is taken of this fact and choice varieties of *vinifera* are grafted on stocks of *riparia*. The other advantage of grafting is that rare varieties, and varieties difficult to propagate from cuttings, can be multiplied rapidly. All our varieties belong to *vinifera*. Phylloxera is unknown here and as propagation is simple, I shall not describe the various methods of grafting. I shall, however, mention another advantage claimed for grafting. It is believed that among other effects of grafting there is a constant weakening of the scion, increased fructification, a greater number of more closely set bunches with large berries, more juicy and frequently richer in saccharine matter, and early ripening (*see* Viala and Rivaz in *American Vines*). Husmann *American Grape-growing* and *Wine-making*) also believes that grafting increases fruitfulness, the temporary obstruction seeming to have the effect upon the graft of making it produce more and finer fruits than on its *own roots*. He has also recorded the opinion of some other eminent growers. If grafting has such an effect we may take advantage of it and make some of our shy bearers yield more and better fruits. The matter seems worth investigation. I have grafted a few vines of Fakari variety on Bhokari as stock. The results of the experiment will be closely watched.

5. *Preparation of the Soil.*

Having selected a suitable location for the vineyard, the preparation of the soil is of primary importance. As deep ploughing will be impossible and undesirable when once the vines are established, it is very necessary to give the site a deep ploughing during the cold weather after the removal of any crop grown. The object of this deep ploughing is to exterminate Hariali (*Cynodon dactylon*) and other weeds, as far as possible. During the hot weather the ground should be levelled and then repeatedly worked with a country harrow (वखर or कुळव). At the beginning of the rains san hemp (*Crotalaria juncea*) should be sown broad-cast and ploughed in after 6 weeks as green manure. This treatment will also improve the texture of the soil. The plot should be again deeply ploughed in October or November. A soil so worked up is ready and thoroughly suitable for planting the rooted cuttings. Any neglect in the preparation of the soil in the very beginning will result in the obnoxious growth of Hariali and other weeds.

6. *Laying out the Plantation.*

At Nasik the vines are generally planted on the square system, the distance between the rows being 6 to 7 feet and the vines at the same distance in the rows. I prefer 7 feet. This distance is suitable and allows of easy cultivation by the plough in every direction. East to West, North to South and crossways. The number of vines in one acre when planted at 6'×8', will be nearly the same as when planted at 7'×7'. The former

plan will probably be better as it will allow of easy cultivation and the vines will be better exposed to sun light and free circulation of the air. At Limb, in the Satara District, I have seen vines planted 9′ apart and trained to four stakes round every vine. This system of planting and training does not allow of easy cultivation by the plough; nor have I noticed any distinct advantage over the square system adopted at Nasik.

The four sides of square are equal to one another and the two diagonals are equal. A square of suitable dimensions is first marked on the ground, nearly in the centre of the plot. Lines are drawn along the two parallel sides of the square and markers placed along the lines. The lines are then moved at a distance fixed upon and parallel to the two sides placing markers along them and so on. When markers are placed along the lines in the farthest position of the plot furrows are opened by the plough along the lines indicated by the markers. The lines are then drawn along the other two sides of the square and markers are placed at the points where they cut the furrows. The lines are then moved parallel to, and at the distance chosen from, the two sides putting markers at points cutting the furrows and so on. Cross furrows are again opened in the direction indicated by the second set of markers. In this way the whole field is laid out. The places where the furrows cut one another are the places where the young vine plants should be planted. Occasionally a few squares are checked to see if all the sides are equal, as also the diagonals. This is somewhat a tedious process and now and then the rows do not run straight.

I do the laying out by means of a cross-staff, three or four lines and a suitable number of small stalks of san hemp which serve for markers. Having determined the position and direction of one end row, two strong pegs are driven at the extremities of the line. The cross-staff is then set on this line and an off-set is taken to the other side of the field by means of the sight-vane. A suitable point on this off-set is chosen which should be in the opposite end row. A peg is driven into the position of the cross-staff in the first end row. The cross-staff is then removed to the point chosen in the opposite end row and adjusted so that the flag on the peg driven in the first end row is clearly visible. The sight-vane looked through at right angles will determine the direction of the second end row, which will run parallel to the first. A line is drawn tight in the direction and a peg driven in the place of the cross-staff. Distances along these two lines (end rows) are measured and markers placed. Then a third line is drawn across the two pegs, *i.e.*, one in the first end row and the other in the opposite end row. Distances are measured (from the first end row) and markers placed along this line. Then this line is moved to the two markers next the pegs, distances are measured and markers placed. Again the line is moved to the next pair of markers, distances measured and markers placed and so on. In this way, the plantation is laid out very accurately.

It is advisable that the rows should run parallel to the prevailing direction of the winds.

7. *Planting.*

Having laid out and marked the plot as described in the preceding section, holes or pits, 9″ wide and as many inches deep, are dug out in the position of the markers or where the furrows cut one another. Into these holes the rooted cuttings are transferred in the first week of January. The

cuttings are very carefully taken out from the bed in the nursery, with some earth round the slender roots so as to cause the young roots as little injury as possible. In planting, half a basket to one basket (10 to 20 lbs.) of well decayed farmyard manure is mixed with the earth. The cuttings are placed in the holes, and the earth and the manure are firmly pressed round them by the foot.

For irrigation the plantation basins and channels (आळीं सारळया) of convenient dismensions are made. The first watering is given immediately after planting ; in fact planting and watering are done simultaneously so that the man in charge of watering follows the man in charge of the planting.

The second watering is given on the 3rd or 4th day after planting.

As a few of the transplanted cuttings may fail to grow sufficient cuttings are left in the nursery to fill such blanks. This precaution should always be taken. Blanks should be filled in the early stages of the plantation. Whence once the plantation is thoroughly established it is very difficult to fill blanks satisfactorily.

After the second watering, water should be given every 5th or 6th day.

8. *Training the Grape-vines.*

In the last section planting the grape-vines was fully described. It is assumed that the young vines have received two waterings. For the next five or six weeks watering must be done every 5th or 6th day. The soil in the basins round the vines must be stirred a day before every watering or at least once a fortnight. If all the necessary precautions in the preparation of the soil have been taken and the details of transplanting and watering carefully followed, the young vines will begin to make vigorous growth in the second week of February. At this time half a basketful (10 lbs.) of night-soil manure or any other well decayed organic manure should be given to every vine. Now the important work of training the vines begins.

Pruning and training the grape-vine are perplexed questions. The terms, which are often confounded when speaking of the grape, represent distinct operations. Training refers to the disposition of different parts of the vine ; while pruning refers to the removal of some branches with a view to insure better and larger fruit on the remaining branches. We train plants for our convenience, but we prune them for effect. There are various systems of training the grape according as the fancy of the grower or the well-being of the vine may suggest. Some systems have decided advantages. This much is certain ; some kind of training and pruning is essential, for a vine will not often bear good fruit when it lies on the ground. I shall first describe the system of training practised at Nasik.

Single-stake or Nasik System.—Explanation of terms—A growing leafy branch of the grape is called a shoot; a ripened shoot is a cane. The point on a shoot or cane from which a leaf arises is called a node. The portion between two nodes is an internode. The acute angle formed by the leaf with the shoot or cane is called an axil, and anything growing from the axil of the leaf is termed an axillary organ.

As the shoot grows and elongates, fresh young shoots are developed from the axils of the leaves. If these axillary shoots are not checked they will grow into many branches or laterals, and the upward growth of the main shoot will be retarded. The object to be aimed at is to grow two or three main shoots to a convenient height, say four feet six inches. Then it is evident that the shoots from the axils, or laterals, must be suppressed, so as to throw the vigour of the vine into the main or leading shoot. This is done by pinching off by the thumb and finger all laterals on the main shoots as they appear, bearing in mind that the leaf on the node is not to be pinched. These leaves on the main shoots ripen them and make them stocky.

As the shoots grow up, they will not be able to stand erect unless supported. For supports thin canes of Karvi or Mela (Karvi is *Strobilanthes callosus*, natural order *Acanthaceæ*) six feet long are used. They are driven in the ground to a depth of one foot just near the vines. Thin canes of some other plant will do as well if Karvi is not available. The vines are tied to these Karvi supports from time to time as the shoots continue to grow up. *Plantain fibre is used for tying. The plantation should be gone* over every day or every third day, and the growing shoots should be tied to the Karvi stakes so as to keep them straight, but the tying should not be tight, also laterals should be pinched. Here I may suggest that only laterals below nine inches from the growing shoot should be pinched so as to avoid any injury or accidental breaking of the tender leading shoots; this precaution should also be taken in tying. Any shoots coming from below the ground is a *sucker*. If the main shoots are growing vigorously suckers should be suppressed as they appear. In cases where main shoots are not growing normally, suckers should be encouraged and trained to the Karvi stakes in place of main shoot. If all goes well, the growing shoots will attain to a height of four feet or four feet and six inches in the middle of April or the beginning of May. From the beginning of April laterals near the top of the shoots should be pinched cautiously so that when the top reaches to a height of four and a half feet the growing end should be pinched and 4 or 5 laterals below should be allowed to grow which will give 4 or 5 branches or secondary canes.

As the secondary canes grow the Karvi stakes will be unable to give supports to the vines and other supports must be provided. For this purpose green Pangara posts $2\frac{1}{2}$ to $3\frac{1}{2}$ inches thick and 7 feet long are used. (Pangara is *Erythrina indica*.) Teak posts will do as well, but Pangara is cheaper and it strikes roots and grows easily. In April the posts are placed vertically in holes 18" deep near the vines and the earth rammed about them by a wooden bar. The Karvi stakes and the vines are then tied in three places to the Pangara posts with plantain fibre. Thin strings or ropes should not be used for tying. This is how vines are trained at Nasik.

Other methods of training. In America and elsewhere the grape is trained to a wire trellis. There are three distinct types of training with a number of modifications. The main types are :—(1) The Upright system, (2) the Horizontal system and (3) the Kiffin or Drooping system. The advantage claimed for these systems of training are :—(1) The energy of the plant is evenly distributed, (2) Pruning is simplified, (3) Fruit is evenly exposed to free ventilation and light and (4) spraying can be done thoroughly and easily. The vines are trained to two or three horizontal wires fixed on wooden posts 15 to 20 feet apart.*

* For detailed information about different modes of training *see* Bailey's "Pruning Book," Chapters VI, VII and VIII.

I have trained a few vines on the horizontal and Kiffin systems by way of experiment and before I see results it will be premature to pass any remarks in favour or against these systems. I may however say this much that they are promising well. For the present I prefer the single stake system of training described above.

9. *Second Year's Treatment.*

First Pruning.—The cuttings were obtained in October and after rooting were planted out in January. In June we have seen 4 to 5 branches or secondary canes growing near the top of the main canes and by the end of September the plantation may be said to have completed its first year. The secondary canes will have grown to 6 or 7 feet in length with firm ripe wood for a few inches near their starting points. They contain the bearing wood of the coming season. They must be pruned to get good fruit. The vine bears its fruit on the growing shoot of the current season. If all the axillary buds on the secondary canes are allowed to grow, the energy of the vine will be divided into a number of buds which will all try to grow, giving weak shoots without fruit. This we avoid by cutting back to ripe wood leaving 3 or 4 buds on the secondary canes. Out of these, one or two buds will grow and give fruit, while some buds near the base of the cane will remain dormant, as the vine exerts its energy chiefly on the buds removed farthest from its head. Thus the first pruning consists in cutting back the secondary canes to 3 to 4 buds. This first pruning should be done during the last week of October in the year of planting.

After pruning, the plantation should be ploughed four times, *viz.*— (1) East to West, (2) North to South, (3) N.E. to S.W., and (4) S.E. to N.W. The yoke used for this purpose is of special short lengh (4 feet 6 inches) so that the bullocks walk side by side with the beam on their flanks. No attempt should be made to plough close to the vines. The plough will thus open 4 to 5 furrows in a row. Deep ploughing is undesirable and a country wooden plough is preferable. After ploughing, basins and channels should be made as usual.

Some 15 or 20 days after pruning the buds begin to swell. At this time a small beetle, known locally as Udaiya (*Scelodonta strigicollis*) eats into the growing fruit buds. If the fruit bud is injured it is lost, as it will not bear any fruit. It is therefore necessary to catch and destroy these beetles. As the vines are quite naked after pruning, the beetles seek shelter against heat and cold. Advantage is taken of this habit. Small bundles of dried strips of plantain leaves are placed on the heads of the vines and the insects seek shelter in them. The bunches are taken into water and the insects drowned early in the morning and at mid-day. This should be done daily till the buds have grown and developed a few leaves.

When the young shoots are 5 to 6 inches long the plantation may be irrigated, if necessary. Water should be given every 12 or 15 days afterwards. The soil in the basins should be well stirred a day or two before every alternate watering.

Any shoot growing out of the vine above ground on any part older than two years is called a water-sprout. If water-sprouts on the main canes or suckers from below apppear they should be rubbed off.

Plantain fibre used for tying will not be strong enough to hold the vines in position. Coir string may now be used. The vine should be tied neatly in three places, but not tightly.

A few flower bunches may have appeared opposite the 5th, 6th or 7th leaf on shoots growing on the secondary canes (or fruiting spurs, *see* Chapter on Pruning). These will give a few stray bunches of fruit which will ripen in March. When all the fruit is removed after ripening, the vines must be pruned a second time in the same year. This is about the beginning of April.

Second or April Pruning.—As stated above one or two dormant buds will be found on the secondary canes. Here again we cut back to one bud ("renewal spur"—see later) just near the base of the secondary canes. The dormant buds will grow and give new canes which will form the bearing wood of the next season.

After pruning, the plantation should be ploughed as before and basins and channels prepared for irrigation. One basketful (20 lbs.) of good farmyard manure or night-soil should be given at this time, before the first watering. It should be perfectly buried in the soil at some distance round the vines and watering should be done every 10th or 12th day till the beginning of June. The soil in the basins should be stirred a few days before every alternate watering. After 1st June watering is not necessary.

After pruning, the Udadya beetles should be caught in plantain leaf bunches and destroyed. At present this is done only once, that is, after the October pruning. If they are caught now (April) as well as in October the insects will have less chance to breed and increase in numbers. I think this to be the best way to hold this insect in check and I strongly recommend it. If all gowers were to take up the matters seriously and systematically the pest might disappear. At Nasik the vine bears twice in a year, once after the April pruning and again after the October pruning. The former is the Khata Bahar (sour crop) and the latter is the Mitha Bahar (sweet crop) (see "*Annual Cultural Treatment*").

None of the vines should be carelessly allowed to lie on the ground. If some Pangara stakes have been broken they should be replaced. The vines should be kept straight and neatly tied. This is all the cultural treatment required till the pruning time in October.

In October the vine is again pruned for fruit (Mitha Bahar). The secondary canes should be again cut back to 3 or 4 buds from the base. The plantation should be ploughed and basins and channels prepared.

Udadya beetles should be caught and destroyed. Any tyings that are too tight should be replaced.

The first watering should be given in the first week of November. Water should be given every 10th or 12th day afterwards. The soil in the basins should be well stirred before every alternate watering.

10. *Third Year's Treatment.*

After the removal of the crop of the last season (Mitha Bahar) the vines should be pruned in the beginning of April. Here again the secondary canes should be cut back to one or two buds from the base (renewal spurs)* Now all these buds will grow and give secondary canes for the next season.

* A cane cut back to a few buds is a spur.

Near these buds there are also two or three dormant buds: these are the extra-axillary buds. Some of these will also grow and give more secondary canes. In this way the number of secondary canes will increase. In pruning, the cut should be always made close to a bud and just a quarter of an inch beyond it. If there are any dead spurs they should be cut clean out. The soil treatment is as usual.

No watering should be given till the young growth is 9 to 12 inches long and all the blossom has come out. Water is generally given in the second week of November. From this time it should be done at an interval of 12 to 15 days. The soil in the basins should be stirred at every alternate watering.

A careful watch should be kept for mildew. As soon as it makes the least appearance the whole plantation should be thoroughly sprayed with Bordeaux mixture (*see* Chapter on Fungoid Diseases).

The Mitha Bahar crop will ripen in March.

11. Annual Cultural Treatment.

From what has been said above regarding the second and third year's treatment, the reader will have perceived that the vines must be pruned twice every year at Nasik, as the grape-vine there has at least two seasons of growth. As fruit is borne by young shoots from buds on canes of last season's growth, it is necessary to prune the vines before active growth has commenced.

April Pruning.—As soon as the ripe fruit in the whole plantation is removed the vines should be pruned. When a cane is cut back to 1, 2, 3 or 4 buds it is called a spur. In October pruning the secondary canes were cut back to spurs of 3 or 4 buds (fruiting spurs). In April pruning the spurs should be shortened to one bud or in some cases to two buds (renewal spurs). The rule is that at the October pruning the spurs should be lengthened to 3 or 4 buds away from the head of the vine and at April pruning the spurs should be shortened as close to the head of the vine as possible leaving one bud only. This alternate lengthening and shortening maintains the shape of the head and also keeps the vines within manageable limits. The particular time of pruning will depend on varying circumstances. It must be done on some day in the last week of March or 1st week of April. The pruned portions or vine-brush should be gathered and hauled out of the plantation. It is usually left in awkward positions near the plantation and is used as fuel afterwards. The prunings often times harbour eggs of aphis or other injurious insects as well as spores of fungi. The eggs may hatch or the spores may be carried by winds and both may do a great deal of damage. On this account it is preferable to burn the prunings and to return the ashes to the plantation.

Old dead bark comes off easily after each pruning; it should be carefully removed as it will make a convenient home for Udadya beetles and other insects, if left on the tree.

The young shoots on April-pruned vines will bear blossoms in the 5th or 6th week and fruit will set. This fruit does not ripen in the rains and is therefore useless. This is the Khata Bahar or sour crop. It fetches a poor price. Since excessive or repeated pruning weakens the energies of the plant and has an influence on its longevity, I prefer to pinch off the blossoms before

the fruit has set. This is not the general practice, nor have I noticed any evil effects of allowing the vines to bear. I have merely made the suggestion on general considerations.

In August the vines will be found attacked by mildew, the leaves presenting a pale and sickly appearance. The leaf performs the important function of elaborating crude sap and enables the plant to build up new plant-tissues. If these organs—the leaves—are diseased by mildew or any other cause they will not perform their important function of elaborating crude sap and the plant will not be able to build up healthy tissues. On this consideration it is desirable to save the leaf-surface from attacks of mildew. When the leaves are healthy, the vines will give healthy canes with ripe wood and well formed buds, which is very essential for fruiting next season. For this reason I suggest that the leaves should be protected against the attacks of mildew. This can be done by spraying the vines, in the middle of May, with Bordeaux mixture and soft-soap. I have given this May spraying for more than 4 years and I have noticed that the leaves so protected remain healthy till pruning time in October, and give good canes with ripe wood. The new growth after the May spraying may be attacked by mildew, but the leaf-surface protected by spraying remains healthy. I may admit that a comparison between the crop of May-sprayed plantation and that of one not sprayed in May gave no indication that May spraying was necessary. However on the theoretical grounds stated above I am in favour of May spraying and would recommend it.

Green Pangara stakes strike root and produce leaves and branches The foliage will form a canopy and shade the vines. This is objectionable as it will interfere with free ventilation and sunlight. So it should not be allowed. One or two branches should be allowed to grow straight and all horizontal branches should be cut away and fed to cattle. These will eat it with relish as green fodder.

Blossoms will appear opposite the 5th, 6th or 7th leaf. When all the blossoms have appeared the plantation should be sprayed with normal Bordeaux mixture as a precaution against mildew.

The first watering should be given just at the time the flowers are opening. It should be done every 12th or 13th day afterwards. The soil in the basins should be well stirred after every alternate watering.

When all the fruit has set, a second spraying with Bordeaux mixture of half the normal strength should be given. The mildew will then not give any trouble. Should it, however, make its appearance the bunches only should be sprayed with ½ normal Bordeaux mixture. 1/2

This is the routine of normal cultural treatment.

12. *Pruning the Grape-Vine.*

Pruning means the removal or cutting away of such parts of the plant as are considered unserviceable or superfluous in view of the object the operator has to attain. It includes pinching of shoots, cutting of branches and roots and removing lateral and main tops.

In pruning the grape the objects aimed at are :—

(1) To regulate the shape of the vine in conformity with a definite plan of training as suggested by the fancy of the grower.

(2) To concentrate the energy of the vine, in the early stages of growth, towards the terminal or leading shoot by checking its distribution towards the laterals.

(3) To attain greater vigour in the plant; for, by cutting off a portion of branches the energy of the plant that would have been diffused over the whole is concentrated on the parts left; and hence stronger growth results.

(4) To obtain more and better fruit.

(5) To correct faults of 'habit' such as suckering and water-sprouting.

All intelligent pruning of the grape rests upon the fact that the fruit is borne in a few clusters near the base of the growing shoots of the season, which spring from wood of the last season's growth.

It should be said here that a cane cut back to 1, 2, 3 or 4 buds is called a spur; a branch or trunk more than one year old is called an arm. A spur with three or four buds is a fruiting spur: and a short spur with one bud is called a renewal spur.

In other countries, with only one season of growth, the vines are pruned once every year. Here we have two seasons of growth and as remarked elsewhere the vines will bear twice in the year. Hence it is that the vines must be pruned twice every year, for shoots from wood of more than one season's growth will not bear so freely and readily. For convenience I have called the two prunings April and October pruning.

In October pruning the canes of the last season are cut back to fruiting spurs with 3 or 4 buds. As the vine exerts its energy on buds removed farthest from the head, only one or two buds near the end of the spurs will grow and bear fruit, the others remaining dormant. If we cut back the new canes to 1 or 2 buds in April, the spurs (arms afterwards) will be constantly lengthening and the form of the head will not be maintained. The bearing wood must also be maintained as near the head of the vine as possible. So in order to maintain the shape of the vine within manageable limits the last fruiting spurs are new cut back in April to spurs with one bud (renewal spurs). The bud on the renewal spur will be very near the starting point of the fruiting spur. The canes from these renewal spurs are cut back in October to fruiting spurs; while these fruiting spurs are in their turn again cut back in April to renewal spurs. Every year the spurs are, in this way, alternately lengthened and shortened and thus the shape of the head is maintained.

If the system of pruning is followed rigidly, the number of spurs will be but limited. There must be a sufficient number of spurs for a fair crop. As the age of the vines advances the spurs increase in number. Near every bud there are present more than two extra-axillary or adventitious buds; some of these will start vigorously and give additional canes for fruiting. If the shoots from such extra-axillary buds are weak they should be pinched when four or five inches in length. Also instead of one, two buds are occasionally left on the renewal spurs so as to increase the number of fruiting canes or spurs. In this way the number of spurs is increased. The number is regulated by the vigour and age of the vine; the older the vine the greater the number. I have seen as many as 40 spurs on a twelve year old vine.

In some varieties the buds or eyes near the base are fruitful; while in others the 4th, 5th and 6th buds from the base are more fruitful. What buds to leave is a question which will depend on a particular variety. In the Bhokari variety the third or fourth buds are more fruitful and the above system of pruning is recommended for that variety. The principle is, however, the same and the grower should adapt his system to suit his particular case.

Proper method of making the cut.—It is by no means a matter of indifference just where the pruning cut is made. The internodes are filled with soft pith; but at each node there is a growth of hard wood extending through the cane. If the cut be made in the middle, the pith will shrink away and the wound will not heal easily. But when the cut is made just above a node, there is a protecting layer of wood below which facilitates the healing over of the wound. So in pruning vines the cut should be made just beyond the last bud on the spur.

Dead spurs and deformed arms should always be pruned clean so that the head should present a clean, a tidy appearance. An intelligent grower will use his discretion in pruning his vines so that all the arms and spurs are evenly distributed upon the head. When looked upon from above, the head should look like the palm of the hand—for which reason it is called a *Panja* (*i.e.*, Palm) at Nasik.

Here I shall allude to what is known as summer pruning or pinching. The object is to obtain large and heavy bunches by pinching off the growing shoots of bearing canes and thus throwing the vigour of the vine towards the bunches I had tried this when the canes were 2½ to 3 feet in length. The results were not satisfactory. Husmann advises that the growing shoot should be pinched off as soon as the last blossom has appeared. If a few buds on the bearing cane start and form new shoots, these shoots should be again pinched after the 3rd or 4th leaf. This second pinching will be quite sufficient as generally no new shoots will be formed. This pinching is worth trying.

Pruning Tools.—Pruning is usually done by the *Narkat* which somewhat resembles a bill-hook. It makes a slanting cut; the canes are often split and a few buds are lost. Dead spurs and old arms cannot be removed easily by the *Narkat*. I prefer pruning shears (Secateurs). They do the work better than a *Narkat*. The cut is clean and smooth; the canes do not split. Dead spurs can also be pruned clean. The most essential pruning tools are three—a heavy knife, pruning shears and a narrow saw.

13. *Manures.*

Our experience of the practical use of artificial manures is hardly yet definite and whether their use will benefit fruit growers in India is a question which will have to be decided by experiments. That European and American growers obtain heavy crops by the application of artificial manures is a fact which may indicate a similar possibility here in India.

A good rule in sound agriculture is that whatever is removed by crops from the soil, must be returned to it in some other form. From 95 to 99 per cent. of the entire mass (weight) of agricultural plants is directly or indirectly taken up from the atmosphere, while from 5 to 1 per cent. is taken up from the soil. The mineral constituents derived from the soil such as Potash, Lime, Iron, Phosphoric Acid and Sulphur are of primary

importance and are indispensable. Potash and Phosphoric Acid play an important part in the formation of fruit A liberal supply of Nitrogen will induce leaf and wood growth even at the expense of fruit. While Potash and Phosphoric Acid with a moderate supply of Nitrogen will increase the quantity and quality of the fruit.

Let us consider what we take away from the soil by crops of grapes. Leaving Nitrogen out of consideration for the present we know that the ash or mineral matter in grapes and vines (brush) contains :—

Ash of		Potash per cent.	Phosphoric Acid per cent.
Grapes	...	43·32	19·11
Vines (brush)	...	35·44	15·28

One ton of grapes or vines will remove from the soil—

Grapes	...	11·87 lbs. Mineral matter.
Vine (brush)	...	46·0 lbs. do.

The vines bear twice and are pruned twice. The brushes in one acre plantation will weigh nearly two tons : while six tons of grapes per acre (in March) is a fair crop, where as one ton in the rains will give a total of seven tons in the year. That is, seven tons of grapes and two tons of brush will extract from the soil in one year 83 lbs. and 92 lbs. mineral matter respectively. The mineral matter will contain 68 lbs Potash and 30 lbs. Phosphoric Acid.

That is, vines in one acre alone will remove from the soil 68 lbs. Potash and 30 lbs. Phosphoric Acid. The young growth on the 'Pangara' stakes is repeatedly removed and fed to cattle; also many growers remove for fodder the luxuriant growth of grasses and weeds in the rains. If we take into account the minerals removed by these two, it will not be an over-estimate to say that in a one acre plantation the total quantities of Potash and Phosphoric Acid annually removed from the soil are 125 lbs. Potash and 50 lbs. Phosphoric Acid. According to the golden rule stated above the same quantities of the minerals must be returned to the soil so as to maintain its natural or original fertility.

At present growers use farm-yard manure, Poudrette, or town-sweepings. The composition of any of the three manures varies considerably, chiefly depending on the method of manufacture. In most cases no special care is taken in the preparation of the manures, the heaps being never protected against the sun and rain. The richness of the manure will also depend on the feed of the cattle producing the manure. As a rule the manure heaps are neglected. For these reasons I take the lowest percentage of composition. The percentage of Potash and Phosphoric Acid in the manures, so prepared, will be :—

		Potash per cent.	Phosphoric Acid per cent.
Farm-yard manure	...	0·44	0·1 to 0·25
Poudrette	...	0·90	1·00
Town-sweepings	...	0·60	0·50

If 800 vines are planted in one acre and 5 to 10 lbs. of any of the above manures are given to every vine, then 8,000 lbs. are annually applied to one

acre. Thus the total quantities of Potash and Phosphoric Acid returned to the soil would be :—

Manure.	Potash, lbs.	Phosphoric Acid lbs.
Farm-yard ...	35·2	20
Poudrette ...	72	80
Town-sweepings ...	48	40*

Thus we see that excepting the Phosphoric Acid in Poudrette in no other case is Potash or Phosphoric Acid returned to the extent of what was removed from the plantation.

It may be pointed out that the soil contains the minerals and forms an almost inexhaustible source of them. To all appearances this may be true, according to Dr. Mann, a Deccan soil has the following average composition ----this being one of the lighter forms of black soil :—

	Per cent.
Organic matter and combined water ...	12·00
Oxide of Iron and Alumina ...	20·30
Lime ...	2·20
Magnesia ...	1·40
Potash ...	0·40
Soda ...	0·20
Phosphoric Acid ...	0·06
Insoluble Silicates ...	62·00

The weight of soil to a depth of one foot in one acre will be nearly 3,500,000 lbs. and as it contains 0·40 per cent. Potash and 0·06 per cent. Phosphoric Acid, there are present in it 14,000 lbs. Potash and 21,000 lbs. Phosphoric Acid. If we return 50 lbs. Potash and 10 lbs. Phosphoric Acid less every year than what is actually removed, still there is sufficient Potash and Phosphoric Acid to last for 300 years and if we go to a depth of 2 feet the stock of minerals is more than sufficient for 800 years.

This may be true theoretically. Practically the minerals will gradually become rarer and rarer, and will not be so readily available to plants. It should be borne in mind that Potash may remain, in combination with other minerals, as insoluble and locked up in the soil. Only a minute proportion of the total Potash is soluble by root action. This Potash is the *available Potash which alone can be taken up by plants. Some of the insoluble Potash* will gradually become soluble by disintegration of soil particles. Besides

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* Average composition--

Manure,	Potash per cent.	Phosphoric Acid per cent.
Farm-yard ...	1·00	0·6
Poudrette ...	1·53	1·89
Town-sweepings ...	0·77	0·67

and the amounts of the two minerals in 8,000 lbs. of any of such manure will be :—

Manure.	Potash lbs.	Phosphoric Acid lbs.
Farm-yard ...	80	48
Poudrette ...	120	151
Town-sweepings ...	61	53

much of it cannot be appropriated by roots, the foraging capacity of which will be taxed to the utmost limit in order to collect the requisite quantity of the minerals for a fair crop. It may be that the soil will not be exhausted and reduced to a state of sterility. It may yield some crops for many a year, but there will be a gradual reduction of producing power below the point of remuneration. The soil is a colossal bank with vast quantities of minerals for capital. If the share holders (mankind) continuously draw and live upon the capital, the bank will, in the course of time, pay reduced dividends (crops). The share holders are entitled to dividends only and must return to the bank almost all the loans they may have accepted. On the whole, therefore, it appears that the golden rule is absolute and holds good without exception and that in order to maintain the natural or original fertility of the soil, the quantities of the minerals removed by crops must again be returned to the soil.

It was shown that in the present practice of manuring less Potash and Phosphoric Acid were returned to the soil than were removed. This deficit may be made good by the application of Sulphate of Potash (or sometimes of Muriate of Potash) and Bonemeal, or Super-Phosphate of Lime. Commerical Potash Sulphate contains 28 to 31 per cent. Potash, and Bonemeal contains 21 per cent. Phosphoric Acid. 2 to 3 cwts. of Sulphate (or 4 to 6 oz. per vine) and 1 to 1½ cwts. Bonemeal (or 2 to 3 oz. per vine) when applied to one acre in addition to ordinary manures will make up the deficit.

On these grounds I am of opinion that the use of artificial manures will give uniformly fair crops. Whether the crops will be heavy, when the supply of Potash and Phosphoric Acid is increased and with what minimum quantities of artificial manures maximum results may be obtained are questions worth investigation.

With the manures as applied at present the vines make a fairly good growth producing canes more than 7 or 8 feet in length. From this I conclude that the supply of Nitrogen is sufficient and more may prove prejudicial. With Poudrette the growth is very vigorous and the crop somewhat better. This may not be due to Nitrogen. The proportion of Potash and Phosphoric Acid in Poudrette is higher and the slight difference in the crop may be due to this fact.

Time for Manures.—At Nasik, the manures are given after the April pruning when no fruit is expected, whereas manure is not given after October when the vines are pruned for the main crop. What led to this practice it is hard to guess, except perhaps it be the accumulated experience of growers.

On the grape-vine, the fruit is borne on the growing shoot of the season from buds on canes of previous seasons's growth. It is nearly three weeks after pruning that the first blossoms appear. The buds must have largely drawn from the reserve stores of elaborated materials in the vines and canes. Weak unripe canes with indifferent buds will not produce fruit-bearing canes. Healthy canes with ripe wood and well formed buds alone give bearing shoots. So it appears that in order to get such canes the vines must receive good nourishment. For this reason our present practice of manuring the vines after the April pruning seems to be really good and there appears no reason for any change. I may, however, suggest that Potash Sulphate and Bonemeal may be applied after October when the vines are pruned for the main crop; while ordinary Farmyard manure or Poudrette should be given after the April pruning. Here I may point out the necessity for clean cultivation. In the above discussion I have shown

that grasses and weeds take up valuable ingredients of plant food, giving less chance to the roots of the vines to appropriate them. For this reason I have insisted in the foregoing chapters that weeds should be removed and the plantation kept clean as far as possible. And I may even go a step further and say that, for one generation at least, the results will be equally good with intense cultivation only—digging and keeping the plantation clean—without artifical manures. The use of artificial manures for their Potash and Phosphoric Acid will not be justified as long as a maximum yield is obtained by intense cultivation alone. I am afraid even artificial manures will not make up for insufficient digging or unclean and inefficient cultivation except perhaps at a much greater cost.

During the last three years I have tried Potasium Sulphate and Bone-meal on a few vines. The results were somewhat satisfactory though not quite convincing. I am now giving them a fair trial on a large scale. If other growers will use artificial manures and record their experience the mass of evidence so collected will be very valuable as it may directly influence the cultivation of other fruits such as oranges, Mosambi and figs, &c.

14. *Fungoid Diseases of the Grape-Vine.*

[In consultation with Mr. S. L. Ajrekar, B.A., Assistant Professor of Mycology, Agricultural College, Poona.]

There are a large number of Fungi recorded as being parasitic on the grape-vine; but only those that have been observed in the Bombay Presidency will be described here.

Powdery mildew (Bhuri) due to the Oidium stage of probably *Uncinula necator* (Schw.) Burr. The *Uncinula* stage, however, has not so far been observed here.

This is by far the commonest and most important fungoid disease of the grape-vine in this Presidency. It first appears on both surfaces of leaves as ashy-white, roughly circular spots, which later extend, coalesce and may cover the whole leaf causing it to appear as if dusted over with flour. Later on it attacks the blossoms and berries. The affected parts are retarded in growth, and the leaves becomes shrivelled up, mildewed blossoms may fail to set their fruit, and such berries as are formed develop very irregularly and fail to ripen.

The flour-like appearance is due to countless little egg-shaped spores of the fungus, which are superficial and are borne on the body of the fungus which derives nourishment by means of special sucking organs which penetrate the epidermal cells of the affected parts. The usual times of appearance are in July or August and again in November or December.

The damage done is very serious, especially in shaded, ill drained and poorly ventilated situations. Close planting should be avoided and the general principles of plant sanitation should be carefully observed. This is accomplished by attending carefully to details of cultivation described in the foregoing chapters. In addition to this, preventive sprays of Bordeaux mixture should be given.

Bordeaux mixture is prepared as follows :—

Take—

Copper Sulphate	... 12 lbs.
Slaked Lime	... 12 lbs.
Water	... 100 Gallons

Dissolve the Copper Sulphate in three gallons of hot water in a wooden tub. Mix the lime in a bucketful of water into a thin paste. Pour the copper sulphate solution and lime paste simultaneously in a wooden cask containing 30 to 40 gallons of water and stir well. (If a bright steel blade dipped in this mixture turns red by the deposition of free copper the mixture will burn green leaves and more lime should be added till no copper is deposited on the blade.)

Add water to make up to 100 gallons. This mixture is called the *normal Bordeaux mixture.*

The addition of 10 lbs. of soft-soap is recommended. Soap may not be necessary when there is no danger of the mixture being washed away by rain.

It should be remembered that Bordeaux mixture is a preventive rather than a remedy and it must be applied in good time. At present, growers seem to think that a spraying on the appearance of the mildew will do quite as well. *This view is quite wrong.* A plantation must be sprayed and protected against mildew as soon as the vines have made some young growth so that when the mildew attacks the vines after spraying it will be prevented from doing serious mischief. The time and the number of sprayings as also ths strength of the mixture may be varied according to circumstances. I think that two sprayings after the October pruning are necessary and a third may be given if required when the bunches only should be sprayed. The following table will serve as a rough guide :—

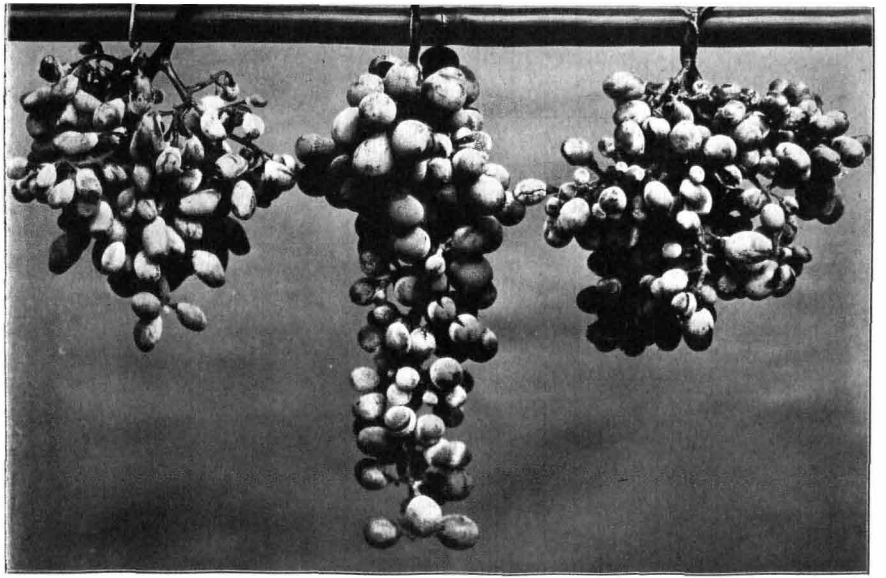
Spraying.	Strength of mixture.	Time.
1.	Normal.	1st week in November.
2.	$\frac{1}{2}$ Normal.	2nd week in December.
3.	$\frac{1}{3}$ Normal.	In January if necessary when the bunches alone should be sprayed.
May-spraying.	$\frac{1}{2}$ Normal with soap.	3rd week in May.

In a preceding chapter the advantages of May-spraying are discussed.

*There is always the danger of infection even to a sprayed garden from a neighbouring unsprayed one and hence concerted action on the part of all the growers in a particular locality is urgently needed if the disease is to be stamped out. In some foreign countries legislation has been called into action in order to secure such concerted action.

2. Downy mildew, due to *Plasmopara viticola* (Berk. and Curt.) Berl. and De Toni, is much less common than the Powdery mildew. All green parts of the vine are liable to be affected; but particularly the leaves on which spots are produced which are at first yellowish on the upper surface and become brown later on. On the lower surface of the leaves at places corresponding to the yellowish discolouration on the upper surface are seen the reproductive parts which show as a velvety or downy white growth. The vegetative parts of the fungus are inside the tissues of the affected leaves. The spots are usually well-defined and limited in number; but occasionally they may extend over the whole leaf and kill it. This mildew has so far been observed only on leaves in the Bombay Presidency;

* The reader may refer with advantage to Bulletins Nos. 36 of 1910, 45 of 1911 and 51 of 1912 issued by the Department of Agriculture, Bombay Presidency, which give details of the experiment in the treatment against mildew.



Mildewed Grapes.

but it is known elsewhere to attack twigs and berries and to cause great damage. The usual time of appearance is from September to February.

Treatment.—Bordeaux mixture used against the Powdery mildew is also effective against the Downy mildew.

3. *Anthracnose.*—The identity of the fungus causing this disease is by no means certain. It has been variously attributed to a species of fungus belonging to the genera *Phoma*, *Glaeosporium* and *Sphaceloma*. The symptoms are characteristic spots on stems, petioles, leaf-blades and fruit. The spots are at first small, dark-brown or black in colour, which soon become greyish and sunken in the centre. They enlarge in a longitudinal direction along the stem and have usually a well-defined dark border. The discolouration descends deep into the tissues, rendering the stem weak and brittle. When the disease occurs on berries, the fruit becomes distorted or cracked and unfit for market and valueless. It may occur at any time in the year.

This disease is not known to have done much damage in the Bombay Presidency so far, but it may become dangerous if neglected. Anthracnosed canes should be cut and burned, and a cleansing wash of Iron Sulphate and Sulphuric Acid solution may be given in badly affected gardens after pruning.

Iron Sulphate and Sulphuric Acid solution is prepared as follows :—

Take—

Hot water	... 100 parts.
Iron Sulphate as much as the water will disolve	... (about 50 parts.)
Sulphuric Acid	... One part.

Disolve the Iron Sulphate in hot water to saturation; then gradually add the Sulphuric Acid while stirring.* This solution (as also Sulphuric Acid) should be used with great precaution as it is exceedingly caustic and will injure machinery, clothes and nearly everything with which it comes in contact. It is generally applied with swabs made by tying rags about the end of a stick. It will burn leaves and all tender parts of the vine so it must be applied after pruning and before the buds begin to swell and grow. This may be followed with advantage by spraying with Bordeaux mixture after a few days.

European vineyardists seem to have perfect control of Anthracnose by following the above line of treatment.

4. Leaf-spot due to *Cercospora viticola.*—Irregular dark spots on leaves are produced. This is not a serious disease and the same treatment as for Powdery mildew will easily overcome it.

5. Rust due to *Phakopsora vitis.* This has been recently reported from Karwar district. The time of appearance is from September to February. Numerous small rusty brown spots are produced on leaves which become dried up and fall off as a consequence. The treatment would be rather difficult as in the case of other rust fungi. It seems possible, however, to reduce the damage to a minimum by keeping a close watch on the vines and plucking off and then burning all affected leaves as soon as noticed, and by giving a preventive spray of Bordeaux mixture before the usual time of appearance of the disease.

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* Water should never be poured on strong Sulphuric Acid as it may cause explosion. The Acid should always be added slowly to the water.

For spraying the Prize Bucket Spray-pumps are in use at present. One spray-pump costs Rs. 15. It will do ordinarily. A very superior type of spray-pump is the automatic sprayer made by the Four Oaks Spraying Machines Co., Sutton Coldfield, near Birmingham. I gave some trials and I have found that the automatic sprayer is a wonderful spraying device. It gives a very soft mist like spray without drops. The spraying is effective and economical. The operator has both his hands free so that he can move about and direct the stream in any way. It saves time. One spraying machine of 2½ gallons capacity will cost Rs. 50 nearly. In the long run it will be found to repay its high cost.

15. *Insect Pests of the Grape-vine at Nasik.*

[By Mr. R. S. Ramrao, Lecturer in Entomology, Agricultural College, Poona.]

Only a few insects have been observed which attack the grape at Nasik.

1. *Scelodonta Strigicollis* (vernacular, Udadya).—A small beetle less than one-th rd of an inch in length, and of a dull coppery colour, is a definite pest of the vine at Nasik and in the neighbourhood. The wings show dark spots in two rows. The life history of this insect has not been ascertained. It is probable that it breeds elsewhere on grasses. In the adult stage it is found feeding on leaves and buds of the vine practically throughout the year. The chief danger lies in this that the insects eat into the growing buds as soon as they make a start after pruning. If the buds are injured, even a little, they are lost as they will not bear any fruit. The insects are active at night and the cooler parts of the day. When the sun is hot, they take shelter in the loose (dead) bark on the stems and their knots. Advantage is taken of this habit and they are easily caught in tassels of plantain leaf strips which are placed on the crutches (heads) of the vines. Early in the morning and at midday the tassels are removed and shaken into a bag where the insects drop down and are collected. They are destroyed afterwards. (An earthen pot containing some water with a little kerosine floating over it may be used instead of a bag. When the tassels are shaken over the water, the insects drop down and are easily killed.) The tassels are again placed over the heads of the vines. The work of collecting and destroying the insects is continued till all the buds are fairly out. This plan works well. It is by no means the case that the insects take readily to the tassels when they can find convenient places for concealment. This they do in old dead bark, in hollow knots and dead spurs. When all the loose bark is removed and dead wood and spurs are pruned clean, the insects finding no other places for refuge are readily caught in the tassels. Therefore loose bark, dead spurs and wood should be removed carefully. The knots and crutches examined and if any beetles are found they should be killed.*

* Many growers follow another plan of destroying the beetles in addition to the above method. Small bundles are made from the thin refuse canes of sun-hemp (सनकाडचा). After sun-set the bundles are lighted and the pruned vines-stems, arms, and spurs are tightly smoked by rapidly passing the burning bundles round them. This is done once or twice. On account of the heat and smoke many beetles drop down dead and their number is thus greatly reduced. The growers think that the spurs, arms and buds are rendered bitter by the smoke when the beetles will feel no appetite for them. However that may be the plan works well and the beetles are less troublesome afterwards.

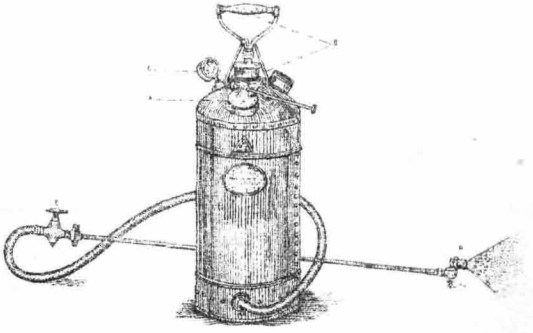

Fig. 3

Automatic Sprayer.

Foot pump for spraying.

2. *Sthenias grisator.*—This is another beetle occasionally found attacking the vines at Nasik. The beetle is about an inch long with long feelers. It is grey coloured and recognised with some difficulty when it is resting on the vines. By means of its strong jaws it eats into the vines (stems) and makes two deep girdles round them in two places 5 inches apart. It has been found to lay eggs on the pieces which often fall to the ground. These pieces should be collected and burned, as also the dead branches. The beetle belongs to a class of insects which live upon dead wood and the girdles it makes round the vines is due to its instinct to provide itself and its progeny with dead wood for subsistence. The girdling is deep and kills the parts above. Vines are thick as one's thumb readily succumb to the attack. The pest appears in November. It is necessary to keep a strict watch for any of these beetles at this time and if any are found they should be collected and destroyed. As the dead wood may harbour its eggs it should also be burned.

16. *Specific Remarks.*

A few remarks on the income and expenditure of a one acre plantation will not be out of place here.

Initial cost of one acre plantation :—

I. First Year—	Rs. a. p.	Rs. a. p.
(1) Sun-hemp seed ...	2 0 0	
Do. sowing ...	1 10 0	
Ploughing in the sun-hemp as green manure 2×2 bullock ploughs, 2 men, 6 women; days three, at Rs. 2-10-0. ...	7 14 0	
	11 8 0	11 8 0
(2) Preparation of the soil— 4 ploughings by 2×4 bullock ploughs; 4 days, at Rs. 3-0-0 ...	12 0 0	
Crushing clods by Maind or Fali ...	1 8 0	
	13 8 0	13 8 0
(3) Planting—		
800 rooted cuttings at Re. 1-0-0 a hundred ...	8 0 0	
Laying out, planting and preparation of basins and water-channels by piece-work at Rs. 1¼ per 100 vines ...	10 0 0	
	18 0 0	18 0 0

	Rs	a.	p.	Rs	a.	p.
(4) Irrigating—						
20 waterings from January to May (inclusive) by 2 bullock-Motas and 2 men, 50 days (or 45), at Rs. 1-12 0 ...	87	8	0			
Proportionate cost of Motas-ropes, &c. ...	12	8	0			
	100	0	0	100	0	0
(5) Stirring the soil in the basins (8 or 10 times), at Rs. 2-0-0 ...	20	0	0	20	0	0
(6) Manure ...	15	0	0	15	0	0
(7) Training—						
Karvi canes ...	1	8	0			
Pangara posts green 800, at Rs. 7-0-0 per 100 ...	56	0	0			
Putting up the posts or stakes, at Re. 1-0-0 per 100 ...	8	0	0			
One man employed to train the vines for 4 months from March to June [inclusive at Rs. 10 (or 8)] per month ...	40	0	0			
Extras ...	4	8	0			
	110	0	0	110	0	0
First year ...				288	0	0
II. Second Year—						
(1) Pruning twice in the year, at Rs. 2-0-0 ...	4	0	0	4	0	0
(2) 4 ploughings twice in the year, by 2×2 bullock ploughs, days 6, at Rs. 3-0-0 ...	18	0	0	18	0	0
(3) Preparing basins and water-channels twice in the year, at Rs. 6-0-0 ...	12	0	0	12	0	0
(4) Manure ...	12	0	0	12	0	0
(5) Coir string for tying ...	2	0	0	2	0	0
(6) 12 Waterings—						
Two 2-bullocks Motas, men 2 and days 30 (or 24), at Rs. 1-12-0...	52	8	0			
Six stirrings at Rs. 2-0-0 ...	12	0	0			

	Rs.	a.	p.	Rs.	a.	p.
(*b*) 12 Waterings—*contd.*						
Part of the cost of Motas, ropes, &c. ...	8	0	0			
	72	8	0	72	8	0
(7) Extra for plantation, leaf tassels, collecting beetles, &c. ...	9	8	0	9	8	0
	130	0	0			
Second Year ...				130	0	0
III. Third Year—						
Same as second year ...	130	0	0	130	0	0
Two or three sprayings with Bordeaux mixture ...	15	0	0	15	0	0
	145	0	0			
Third Year ...				145	0	0
Total Initial Cost:—						
First year ...	288	0	0			
Second year ...	130	0	0			
Third year ...	145	0	0			
Total ...	563	0	0			
Deduct—Value of the crop in the third year (more or less)...	63	0	0			
Net Initial Cost ...	500	0	0			

From the fourth year the plantation becomes more than self-supporting.

The annual cost of cultivation *will not exceed Rs. 150* at the most.

In the above calculation I have made a very liberal allowance for all *contingencies. To some extent it may be an overestimate. It will vary* according to local circumstances.

Income.—It is rather difficult to say anything definitely as to the income from a one acre plantation. Reliable data are not available. It is rarely that the growers dispose of their crops themselves. The crops are generally sold to middlemen, who I believe, make as much as the growers and perhaps more in the case of forward sales. Before the introduction of spraying with Bordeaux mixture much uncertainty prevailed as to the crop prospects, but since the growers are having some confidence in the efficacy of spraying, forward sales will become rare in future. However it will be long before the growers combine into a sort of association in order to dispose of their crop to better advantage. For the present they have to depend upon middlemen. I have seen the crop on a one acre plantation sold for Rs. 400 and sometimes for Rs. 600.

In the absence of reliable data I propose to solve the question in another way. 5 lbs. of grape per vine in the 4th year is a fair crop considering the age of the vine. At Nasik grapes are sold nearly at 2 annas a pound and as there are 800 vines in one acre the value of the crop, at market rate, will be Rs. 500. Deducting *Rs. 150* as the cost of cultivation and Rs. 150 (roughly) for guarding the crop and marketing the net profit of the grower will be Rs. 200.

15 lbs. of grapes per vine is a good crop. The crops which I have seen sold for Rs. 600 were of this nature. That is, at market rate the value of such a crop will be Rs. 1,500. This may seem incredible. But the facts are these: 10 lbs. per vine is an average crop while 15 lbs. is a fair or good crop. There is no overestimate in this. When such a crop is sold for Rs. 600 the grower will realise Rs. 350 net after deducting cost of cultivation. An average crop will be sold for Rs. 400 when he will realize Rs. 250 net. In the latter case the middleman who purchased the crop for Rs. 400 and spent Rs. 200 (?) on harvesting, &c., will realize Rs. 400 since at market rate the value of the crop will be Rs. 1,000. Thus it is that middlemen make as much as the growers and even more.

By intense cultivation and the use of artificial manures it is possible to obtain uniformly fair crops. If grapes were sold as cheap as one anna a pound at least Rs. 300 will be realized from one acre plantation after deducting Rs. 250 for cost of cultivation (in this particular case provision is made for artificial manures, &c.) and Rs. 250 for harvesting, guarding the crop, &c.

The income will fluctuate depending upon the prevailing market rate and the way in which the crop is sold. It is safe to say that after the 4th or 5th year the crop will be between 10 lbs. to 16 lbs. per vine.

Age of the Vine.—I started my first plantation in 1894. After 20 years I find it doing quite well. I see no reason why it should not go on for another 20 years. If old vineyards are renovated occasionally they might do for 60 years After 12 or 15 years the arms and spurs on the heads of the vines get deformed and contorted and the bearing wood recedes from the head. This has a prejudicial effect on the crop. So to avoid this it is necessary to renovate the vines.

Renovating old Vineyards.—The vines send-strong and vigorous suckers from below the ground. In renovating old vineyards such suckers should be encouraged and trained to stakes. If the suckers are retained after the April pruning, the canes will not give ripe wood after the rains and generally no new heads will be formed. When suckers are encouraged after the October pruning they will give nice canes which may bear 3 or 4 secondary canes near the head. These secondary canes should not be pruned in April, but allowed to ripen till October. If necessary, extra manure should be given so as to induce vigorous growth. At the April pruning the old vines should be cut back flush to the ground. In October the branches on the new canes should be pruned as for the first pruning. Renovated vines do not bear as fairly as old vines for sometime. Therefore it will be imprudent to renovate the whole plantation at once. It should be done gradually—say one-fourth the number of old vines every year. (Some severe pruning on the top will readily induce good suckers). in this way the whole plantation can be renovated in four years without serious loss of the annual crop. Water sprouts should not be used for renovating. It is the sucker which should be used; for as the sucker comes from below the ground it will develop new roots and become a new and independent plant.

Hints to beginners.—I think it is possible to grow grapes successfully in many parts of the Bombay Deccan. I had a chance of putting in a few vines at Dhulia. The owner had the satisfaction of collecting some fruit, but owing to a lack of proper knowledge about cultural treatment the vines were neglected and discarded. Beginners should not start a large plantation

at once. I advise them to start with a 100 vines by way of trial. When the first trials succeed it will not be any risk to enlarge the plantation. The first trial should not be given in any old corner of the field. All shaded sites should be avoided.

Different varieties require different cultural treatment; and as a rule they should not be mixed and planted in one plot. Sahibee and Fakari demand the same treatment and they may be planted together However they are shy bearers, and they should be tried cautiously. Bhokari bears abundantly and is in much favour with growers.

Close planting should be avoided. 7 feet for Bhokari and 8 feet for Sahibee and Fakari should be preferred. The rows should run parallel to the prevailing direction of the wind. It will go more towards the success of the trial if the plantation is kept free from weeds. Ordinary organic manures will be quite sufficient in the beginning. By their application the texture and the fibre of the soil is improved. I do not like to use Lime Nitrate, Ammonium Sulphate or Saltpetre as long as I can get organic manure.

I shall be glad to see the cultivation taken up by rich and well-to-do people. I should like to see the fruit grown whenever possible to meet local demand so that mankind will benefit by the rich, lucious and health giving fruit. I have written this book with that object in view and I shall be amply repaid if the attempt succeeds.