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Vigorous passion vines growing on a river flat in the Harvey district.

THE PASSION FRUIT

Its Cultivation in Western Australia

By F. MELVILLE, B.Sc. Agric., Acting Assistant Superintendent of Horticulture

PASSION fruit has been grown commercially for many years in Western Australia, where its delightful flavour has made it very popular. It may be eaten fresh or as a component of fruit salads and preserves, is held in high regard by housewives for flavouring cakes and icing, and more recently has been extensively used in the production of a proprietary aerated beverage.

It belongs to a large group of climbing plants found growing naturally in tropical and sub-tropical countries but, although many species bear edible fruits, only a small number are cultivated commercially, and these generally on a limited scale. Australia, South Africa, Kenya and New Zealand are among the few countries producing passion fruit in commercial quantities under cultivated conditions.

In Australia, the main areas are situated in New South Wales and Queensland but owing to the prevalence of diseases, particularly brown spot and woodiness, expansion has been restricted. Production in Western Australia has always been small due to the limited demand for the fruit on the local market while the introduction of the brown spot disease has also been a factor. Since the war, however, a demand has

been created for factory fruit and this has caused greater interest in passion fruit growing.

Although the passion vine, under natural conditions, is found in a moist sub-tropical climate, it has adapted itself extremely well to the cool temperate conditions which prevail in the fruit-growing areas of this State. It has proved successful throughout most of the fruit belt, which extends from approximately 50 miles north of Perth southward along the coastal strip and foothills almost to the south coast taking in the apple districts from Donnybrook to Manjimup. Success has also been achieved further east in the vicinity of Albany.

Pre-war passion fruit was grown mainly in the warmer hills districts as far south as Donnybrook. Since the war, however, attention has been directed more towards southern districts particularly the Albany-Denmark and Manjimup-Pemberton areas. This increased interest in passion fruit growing resulted from the establishment of processing facilities in this State and the total area planted is now in the vicinity of 250 acres.

The fruit ripens earlier in the warmer areas, and harvesting of the main summer crop can be commenced in January. In the late southern districts picking starts in March and extends to May. There is, therefore, a fairly wide spread in marketing which helps maintain prices at a satisfactory level.

It is common practice to grow passion fruit as a subsidiary to other forms of fruit-growing and also in conjunction with grazing and under this system it has proved a very profitable sideline. Quicker returns are obtained than with most fruit crops and a payable crop should be produced the second summer after planting. However, the vines are relatively short-lived and, where diseases are prevalent, the productive life may be seriously curtailed unless adequate control measures are taken. Commercial plantings up to 15

years old have been seen but usually six years is a good average life for the vines if properly looked after.

SELECTION AND PREPARATION OF SITE

For successful growth, the passion vine requires a sunny position sheltered from cold winds and moderately free from frost. Mature vines will withstand a certain amount of frost, and damage from this cause is not common but it is advisable to select a



Seedlings require a sheltered position with partial shade and should be well thinned to produce sturdy plants.

high frost-free position if possible. Young plants in a tender condition may be damaged, and planting should not be commenced until the danger of frosts is over, while some protection may be necessary during the first winter.

Strong summer land winds can cause serious blemish to the fruit through mechanical damage, and shelter in the

form of windbreaks should be provided under such conditions. In cooler districts, very satisfactory results are obtained when the passion vines are planted with the rows running in a north-south direction since both sides of the trellis receive equal shares of sunshine. Nevertheless, due regard must be given to soil conservation, and planting up and down slopes should be avoided. In situations where brown spot is troublesome, planting the rows in the direction of the prevailing winds may allow the foliage to dry out more quickly after rain or heavy dew and help to counter the disease.

Drainage is probably the most important factor to be taken into consideration in selecting a planting site, for although passion vines will grow in a wide variety of soils, good drainage is essential. The soil should preferably



Vines are ready for transplanting when about nine inches high.

be deep and friable and free from a stiff subsoil which could restrict water movement. Some of the best plantings seen have been on deep sandy soils. The vines need adequate supplies of summer moisture and, where irrigation cannot be supplied, the soil must be

sufficiently retentive of moisture to carry the vines through the summer.

Prior to planting, the ground should be thoroughly cleared. Termites can be very destructive to passion vines and it is important to remove stumps and roots which might harbour them, and to deal with any nests found. Except in very light soils, deep cultivation is advisable to thoroughly stir the soil and, if possible, the land should be fallowed the winter before planting.

VARIETIES

Practically all types of passion fruit grown in Western Australia are varieties of the purple fruited *Passiflora edulis*. The best commercial variety is the medium-sized hard-shelled type which produces heavy crops of high quality fruit. The pulp content is high and the flavour excellent. The Mammoth variety is sometimes grown because of its attractive size and appearance, but although the fruit is large it is often not well filled with pulp while the vines bear lighter crops. The banana passion fruit or *Tacsonia* is grown on a small scale to supply the market when the purple passion fruit is in short supply. Although the *Tacsonia* is a hardier plant, the fruit is inferior, of no use for pulping and cannot successfully compete with the purple varieties.

PROPAGATION

There are no clonal varieties of passion fruit, and vines for commercial planting are raised from seed. It is possible to propagate the plants from cuttings or by grafting on to a wild vine stock but in practice plants grown from properly selected seed are preferable.

There is considerable variation between seedlings as regards cropping and quality of fruit, and a careful selection of seed is therefore essential if a uniformly good planting is to be obtained. Fruits should be collected from disease-free plants known from past experience to consistently bear

good crops of high quality well-filled fruit. Large fruit is not necessarily a criterion of quality since it is often poorly filled with pulp and may originate from a light crop. On the other hand small fruit is undesirable.

Choose well-matured fruit and, if it is desired to keep the seed for some time, the fruit may be allowed to dry naturally and crushed to release the seed or, alternatively, the pulp may be squeezed from the fruit, carefully dried and stored. It is not advisable to keep the seed for long periods before planting.



A young vine trained on a two-wire vertical trellis. Note the stake used for training the young plant to the wires.

Passion fruit seeds may be sown directly from the fresh fruit or the pulp may be fermented for two or three days and the seed carefully washed and dried first. Where germination is not satisfactory, improvement can be effected by treating the seed prior to planting. Various methods have been used successfully but much depends upon the hardness of the seed coat as to the results obtained. Treatment with hot water either before sowing or in the nursery bed is often used, or the seed may be soaked for several hours in water fol-

lowed by immersion in a solution prepared by adding 20 drops of a saturated chlorine solution to one pint of water. Place the container in bright light and allow the seed to soak for one to two hours. Do not allow the seed to remain in the solution once it shows signs of germinating and wash with water before planting.

Plant the seed either in nursery beds or boxes prepared from a free-working, well-drained soil containing a liberal amount of organic matter. Incorporate well-decayed farmyard manure and a light dressing of a mixed fertiliser in the bottom of the bed and fill up with light clean soil. Sow the seed thinly in drills, not more than half an inch deep and nine inches apart or broadcast over the surface and cover with a light sandy soil. A mulch of organic matter spread over the surface is beneficial for reducing moisture loss. The seed bed must be kept moist but not over-watered and germination should take place in from three to five weeks.

The seed is best planted in March, and seedlings should then be large enough for transplanting in the spring. If desired sowing can be carried out in the spring and early summer, but seed is more difficult to obtain at these times.

As the plants grow it is necessary to thin them out to selected strong plants evenly spaced from four to six inches apart. It is important to avoid overcrowding or the plants will grow weak and spindly and give poor results when planted in the field. If the number of plants required is small the seedlings may be transferred at the four-leaf stage to earthenware pots, tins or other

containers. This will obviate the necessity for thinning but only the stronger plants should be selected. Grown this way the plants receive less shock when transplanted in the field.

The seedlings require partial shade and also shelter from winds for satisfactory growth and these requirements may be met by erecting an overhead lath or brush shelter. Provision should be made for varying the amount of shade according to weather conditions and increasing the amount of sunlight as the plants increase in size. Some shade is advisable until the plants are ready to be hardened off prior to planting out.

PLANTING

The young vines are ready for transplanting when about nine inches high. If larger, the growth should be shortened back so that undue strain is not placed on the root system after planting out. Springtime is preferred for planting but the ideal time will vary from mid-September to early November according to the climatic conditions. In the warmer northerly areas, planting may be started earlier than in cooler districts. Before lifting is commenced the bed should be thoroughly watered and, as far as possible transplanting should be carried out on a cool, cloudy day.

The distance between plants and between rows will depend upon moisture supplies available during the summer. Where moisture supplies are limited, wider planting is necessary, but under average conditions 10ft. between rows and 16ft. to 18ft. between plants

proves most satisfactory. It is well to take into consideration the width of cultivation equipment in deciding on row width, allowing that the vines will overhang at least a foot each way in the rows.

In many soils, applications of phosphate and potash do not readily penetrate to the root zone, and therefore a good reserve of these elements should be supplied in the bottom of each hole before planting. To ensure this, open up holes along each planting line 12in. in diameter and 12in. deep and thoroughly incorporate one pound of mixed fertiliser such as potato manure with the soil in the bottom of each hole. If available a light dressing of organic manure such as fowl manure may be added.

Fill in the top soil and plant the young vines at the same level as they were growing in the nursery but ensure that the roots do not come into contact with any fertiliser. On no account allow the plants to become dry during the planting operations and thoroughly



Training a vine on a three-wire horizontal trellis. Where brown spot is troublesome on the horizontal trellis facilitates control measures encouraging a more open type of vine.

moisten the soil around the roots as soon as planted. Should hot, dry weather occur shortly after planting, it may be necessary to provide temporary protection from the sun.

The first summer is a most important period in the growth of the vines. It is necessary for them to become established and make sufficient growth to be well up on the trellis before the following winter. Adequate moisture supplies should be maintained and light dressings of nitrogenous fertiliser such as two or three ounces of sulphate of ammonia or more liberal dressings of fowl manure applied at intervals around each plant to keep them growing strongly.

TRELLISING

Two main systems of trellising are used, namely vertical and horizontal, and various modifications of these have been tried. The vertical type most commonly used here has two wires, one about three inches from the top of the post and the other between 18in. and

2ft. below it and these are strained through holes bored in the posts. This type of trellis has been popular because of the limited materials required and its simple construction. The posts are set 6ft. out of the ground and placed equidistant between the vines. Substantial strainer posts and heavy gauge wire—usually ten gauge—are required because of the very heavy strain which is placed on the trellis when the vines are in full bearing.

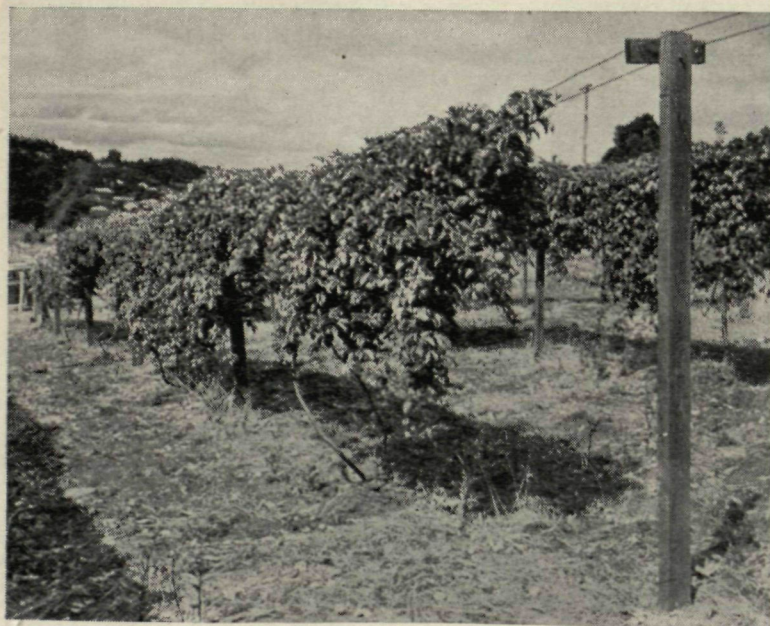
In a slight variation of the above system, two wires are run about 6in. apart horizontally along the tops of the posts usually through holes bored on either side of the post. In this case it is usually necessary to have a third wire about 2ft. from the top to prevent the vines swinging about in the wind.

Horizontal trellises are also extensively used and differ from the vertical type in that two or more vines are run through T pieces fixed to the top of each post. These T pieces may vary considerably in size but 12 to 15in. is usually sufficient. The horizontal trellis has the advantage that it allows mature vines, as well as allowing dead leaves to fall to the ground thus helping in the control of the brown spot fungus and from this point of view is favoured.

MANAGEMENT

Training the Vines.

—Once the young vine has established itself after transplanting it will commence to grow and a number of shoots will form at the base. One or, if desired, two of the strongest are selected and all other growth is suppressed. Fix a strong stake



A narrow type of horizontal trellis. If wide posts are used the wires may be run through holes bored either side at the top of the post.

firmly beside each vine long enough to reach the upper wire and tie the shoots to it. As the shoots elongate, tie at intervals to the stake and remove lateral shoots which develop, but do not remove the leaves on the stem.

In the case of the vertical trellis, if one shoot has been selected, then two laterals are allowed to develop in opposite directions when the lower wire is reached and the main shoot is allowed to extend until it reaches the top wire when the growing shoot is pinched out and two more laterals are allowed to develop one each way along the wire. If two main shoots were used initially, then one is pinched when it reaches the lower wire and the other when the top wire is reached. Whichever method is used the result is one or two main stems and two main arms on each wire.

Where a T-trellis is being used, the shoots are trained in the same way up to the wires where the growing tips are pinched out and laterals allowed to develop, the main arms running in opposite directions along each wire.

Once the main framework has been formed the vines are encouraged to spread the full length of each panel. The laterals which form on the main arms hang down each side of the trellis and gradually produce a complete wall of foliage.

Manuring.—As with tree fruit crops, the main manurial response of passion vines is to nitrogen. This is no doubt due to the ready availability of nitrogenous fertilisers. Phosphate and potash are largely fixed by the clay fraction in the surface layers of the soil and, with the limited root growth in this zone as a result of cultivation and the lack of moisture the availability of these elements is restricted.

The soil organic matter should be maintained at a high level and the most economical way of doing this is by the growing of cover crops. New Zealand blue lupins are ideally suited for this purpose and produce a large bulk of green material. The crop should be turned in not later than the flowering

stage and under no circumstances allow it to compete with the vines for moisture or nutrients when they are commencing their spring growth.

The nutritional requirements of the vines may be best met by applying up to 2cwt. each of superphosphate and potash per acre when sowing the cover crop in the autumn followed by 2cwt. of sulphate of ammonia per acre with the spring cultivation. If irrigation is available, lighter dressings of sulphate of ammonia may be applied during the early summer months as determined by the vigour of the vines and the colour of the foliage. If desired an organic source of nitrogen such as blood and bone or fowl manure may be substituted. In early districts where following the harvesting of the summer crop the vines make new growth and set a late winter crop the application of a nitrogenous fertiliser in March is beneficial.

Cultivation.—The passion vine is a relatively shallow-rooted plant and deep cultivation can have nothing but a harmful effect. The cover crop should be lightly disked in, even if the whole of the plant material is not buried, so long as the plants are killed. Subsequent working of the soil should be restricted to the control of weed growth which is very important where summer irrigation is limited. No good purpose is served by continual summer cultivation simply for the purpose of stirring the ground.

Irrigation.—The fruits of the passion vine are very subject to wilting if moisture supplies are inadequate during the summer months, and considerable losses of fruit and some defoliation can occur from this cause. The condition is most severe where the vines are carrying heavy foliage growth, which results in the withdrawal of moisture from the fruit during times of stress. Therefore, where the soil is likely to become dry for any length of time, irrigation is essential for satisfactory crops. In warmer districts irrigation is also useful in forcing autumn growth for the production of a winter crop.

Furrow irrigation has been most generally used but sprinklers are also satisfactory particularly where the slope is too steep for furrows.

Excessive watering must be guarded against because of the risk of encouraging the Brown Spot fungus and where this disease is prevalent furrow irrigation is preferable to sprinklers.

Pruning.—There is no evidence to show that pruning increases the size of the crop, but from the point of view of disease control and the prevention of mechanical damage to fruit, some pruning is necessary. The amount of pruning required and the optimum time for carrying out the work will vary according to the conditions prevailing in each district.

In warm districts, where the summer crop is harvested by February, it is possible to prune the vines after picking is completed and obtain a regrowth before the cold weather sets in. In cooler areas harvesting may not be complete until early May and it is then too late to prune before the vines enter a semi-dormant condition during the cold weather when they do not respond to treatment.

Heavy pruning carried out during the winter can have disastrous results and therefore in late districts the work is left until the commencement of the spring growth. From the point of view of brown spot control, spring pruning is an advantage since it enables better penetration of sprays applied at this time. The aim should be to remove dead and diseased tissue, also any growth which will allow fruit to drag on the ground, and generally thin out spent fruiting wood to let light and air into the vine, and enable dead infected leaves which have lodged in the vine to drop to the ground.

The fruit is borne on lateral shoots produced from the previous seasons growth and, where this is long and trailing, it should be shortened back. However, excessive shortening of the fruiting wood is not necessary. It is not

as a rule possible to give each vine individual attention, and one practical method of pruning is to shear off all growth to within about three feet of the ground. After a few days it is possible to detect canes entwined in the remaining growth which have been severed from the plant and require removing and at the same time a general thinning is carried out according to the density of the growth.

Cropping.—Vines planted in spring should make sufficient growth during the first summer to flower and set a few fruits for the ensuing winter. However, the first commercial crop will be harvested during the second summer when the vines may carry up to half a bushel per vine. By the third summer up to a bushel per vine can be expected and thereafter crops of one to three bushels should be borne each summer.

The main crop of fruit is harvested during the summer and autumn months, from January till May according to climatic conditions, but in many areas a small winter crop is also produced. Where it is desired to increase the winter crop pruning should be delayed until late October or early November and, provided good growing conditions prevail, a much larger winter crop should be produced. However, this will be at the expense of the summer crop which will be considerably reduced. It is usually possible to pick a few fruits during most of the year.

Under favourable conditions an acre of passion vines in full production will yield up to four tons of fruit equivalent to approximately 250 bushels.

Marketing.—There are two avenues for disposal of passion fruit, namely the fresh fruit market and the processing factory. The factory is interested in bulk quantities available in the summer and during the remainder of the year when supplies are short and prices proportionately high the fruit is sold on the local market.



Healthy vines will produce heavy crops.

Fruit intended for local market should be fully ripe when harvested. In the summertime, this entails gathering the fruit each day since when ripe the fruit falls to the ground and, unless gathered promptly, it becomes sunburnt and useless. At the same time all well-coloured fruits which come away readily from the vine should be picked. In the cooler months of the year the fruit ripens more slowly and less frequent harvesting is necessary.

For local market the stems should be retained and the fruit carefully handled to prevent bruising. If it cannot be packed the same day the fruit should be stacked in a cool portion of the shed and covered to prevent excessive drying. In hot dry weather, pack at least every two days or the fruit will commence to crinkle and its market value will decrease. The fruit should be properly graded to remove all diseased, badly blemished or misshapen fruits and sized before packing.

There is no standard container for marketing passion fruit, but either the half-bushel dump case or the three-quarter bushel flat case is usually used. In the off season, quarter bushel cases are often used. The fruit requires careful packing to prevent damage in transit and should be delivered to market with a minimum of delay.

For factory purposes the fruit is not required fully ripe but should be picked as soon as coloured and may be partly green. This means that picking can be carried out much less frequently than for the local market. Grading is necessary as for the local market, removing all diseased, sunburnt or poor quality fruit. The stalks should also be removed but no sizing is needed other than rejecting the very small fruit. The fruit is usually forwarded in corn sacks.

Diseases.—The most widespread and also the most serious disease with which the passion fruit grower has to contend is brown spot. It is found wherever

passion fruit is grown, although certain plantings may remain free from the disease for years while others in the same district receiving similar attention may be badly affected. Usually in a new planting, brown spot does not become evident until the second or third summer and then is not serious enough to cause alarm. Unfortunately, once established, the disease spreads very rapidly so that whereas the first year it is noticed it may not appear of much consequence, unless proper control measures are taken the following year it may ruin a large proportion of the crop and eventually if neglected cause the death of the vines.

The fungus attacks the leaves, stems and fruit causing defoliation, shriveling and dropping of the fruit and rapid decline in the productivity of the vines. Although signs of the disease may be seen at almost any time of the year as small brown spots on the leaves, the effects are most noticeable in the spring and summer months. Prevention is definitely more successful than cure and unless suitable measures are taken before the disease obtains a hold it may be impossible to prevent serious infection.

Control measures consist of thinning out the foliage during the spring to allow better circulation through the vines and thorough spraying at intervals during the spring and summer months with Bordeaux mixture of 4:4:40 strength. For this purpose a good spray plant capable of supplying sufficient pressure is essential. For full details of the disease, reference should be made to the leaflet dealing with this subject.

Sclerotinia stem rot is occasionally found attacking passion vines causing a shredding of the bark and where the main stem is affected the whole vine usually dies. It is also found attacking such plants as New Zealand Blue lupins and this may supply the source of infection. The control measures for the disease are covered by the requirements for brown spot but damage to the main stems by implements should be avoided.

Trace Element Deficiencies.—In certain areas, deficiencies of trace elements, namely copper, zinc and manganese may occur. Symptoms usually include, apart from unsatisfactory growth, a yellow interveinal leaf mottling and where these conditions are found the grower should consult the local Horticultural Instructor regarding measures to be taken to overcome the trouble.

CONCLUSION

Passion fruit vines are probably best grown in conjunction with other forms of horticulture or grazing and as such can prove very profitable. There are good prospects for expanded production and increased plantings are required to meet the demand for fruit.

Five acres of vines are about as much as one man can manage successfully and then some assistance would be needed at the height of the harvesting period, particularly if the fruit were sent to the local market. However, in view of the various hazards with which the grower is likely to be confronted, it is often wise to plant one or two acres first and then gradually increase the area in succeeding years. As portion of the planting goes out of production so a young section is coming in to take its place.

By this means there will always be a proportion of young vines and it will be easier to maintain a more uniform production. No method of planting will overcome the necessity for adequate attention to disease control and while in some instances diseases are not troublesome, the grower must be prepared to combat them if passion fruit growing is to be maintained on a sound economical basis.

The cost in labour and materials of establishing a passion vine plantation is considerable and although the vines yield a quick return, without proper attention their life may be short. If passion fruit growing is to be financially

sound then the grower must be prepared to apply sound management methods and under these conditions increased plantings are recommended.

ACKNOWLEDGMENTS

Acknowledgment is made to the various growers who enabled suitable

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STORAGE OF ONIONS

The importation of onions at high prices during periods of scarcity may be avoided entirely as a result of some successful cool storage experiments recently undertaken by the Vegetable Branch of the Department of Agriculture.

Through the summer glut period it has often been necessary to export West Australian onions, sometimes at prices which showed a loss to the growers, while later in the season onions were imported from the Eastern States or from overseas sources.

In the experiments, approximately five tons of onions provided by the W.A. Onion marketing Board were placed in cool storage and kept at a temperature of 32° to 34° F. The onions chosen were four lines of the variety Spearwood Brown Globe harvested in mid-February. Two were selected lines and two were fair quality only. Half of each line of onions were stored in crates and the other half in bags.

Cold storage was commenced at the end of March and continued until the end of July, a period of four months, thus making a total of five and a half

months from the harvesting to the completion of storage. The onions were retained under normal shed storage for a week after the conclusion of the trial so that any undesirable after-effects resulting from cold storage could be observed. The onions were then placed on the local market.

It was noted that the low storage temperatures almost completely inhibited the development of shoots and that the onions retained an attractive appearance. The flavour and eating qualities did not appear to be affected.

The onions were check weighed after storage to ascertain shrinkage losses and where necessary they were picked over, and any deteriorated onions removed and weighed. The onions stored in crates showed no losses due to shrinkage and only a 1.4% loss from wastage. Those stored in the bags showed a 2.6% loss from shrinkage and a 3.8% loss due to deterioration. These losses compare favourably with those incurred with potatoes during storage and the storage of potatoes has been a regular practice in this State to assist in the distribution of supplies.

A REMINDER

HAVE you registered your orchard? One fruit tree or a single vine is an orchard for the purposes of the Plant Diseases Act and must be registered accordingly. The registration fee for less than one acre of trees or vines is 1s. Apply Department of Agriculture, Perth.

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