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Plant diseases - Bacterial canker of tomatoes / Cover spray for the control of celery leaf spot / Stunt disease in subterranean clover

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PLANT DISEASES

BACTERIAL CANKER OF TOMATOES

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BACTERIAL canker is perhaps the most serious disease confronting tomato growers in Western Australia. Once established in a planting, it is very difficult to control and it can also persist in the soil or on the supporting stakes from season to season. The disease was first recorded in Western Australia in December, 1945, when it was introduced in seed of the Tatura variety ex the Eastern States. Since then it has become very widespread.

Most commercial growers in this State, stake and prune their tomatoes, and use overhead irrigation—conditions which all favour the rapid spread of the disease. Bacterial canker not only affects the market quality of the fruit but by causing premature death of plants it also seriously reduces the yield.

Pruning is one of the major means of spread of this disease, and in this article reference is made to a possible means of reducing spread by this means.

SYMPTOMS AND EFFECTS

Typically, the disease spreads from the base of the plant upward causing the lower leaves to die progressively up the stem. Death of the leaves is preceded by a gradual marginal withering and upward rolling of the leaflets (Fig. 1) frequently confined at first to single leaflets, or the leaflets on one side of the leaves only which shrivel up before the remainder (Figs. 1 and 2). Eventually the whole leaf shrivels and dies, and hangs down, but it does not fall readily from the plant, for the leaf stalk remains erect and stiff and

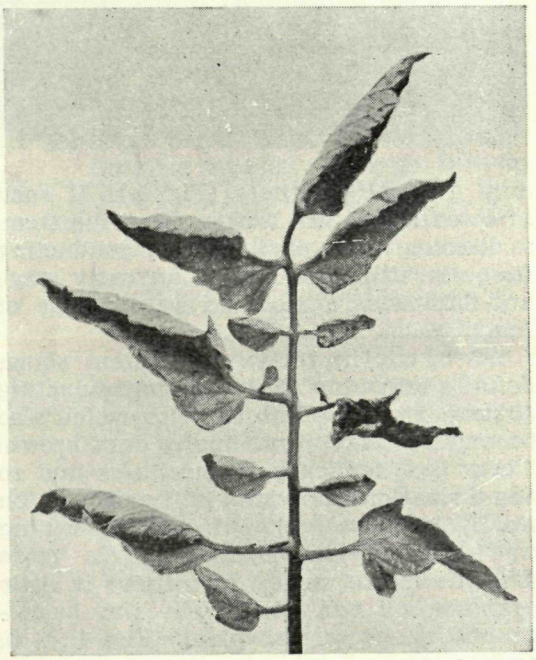

Fig. 1.—Single leaf showing early stages of disease. Note uprolling of leaflets and slight marginal withering. Note also that a single leaflet has shrivelled before the remainder

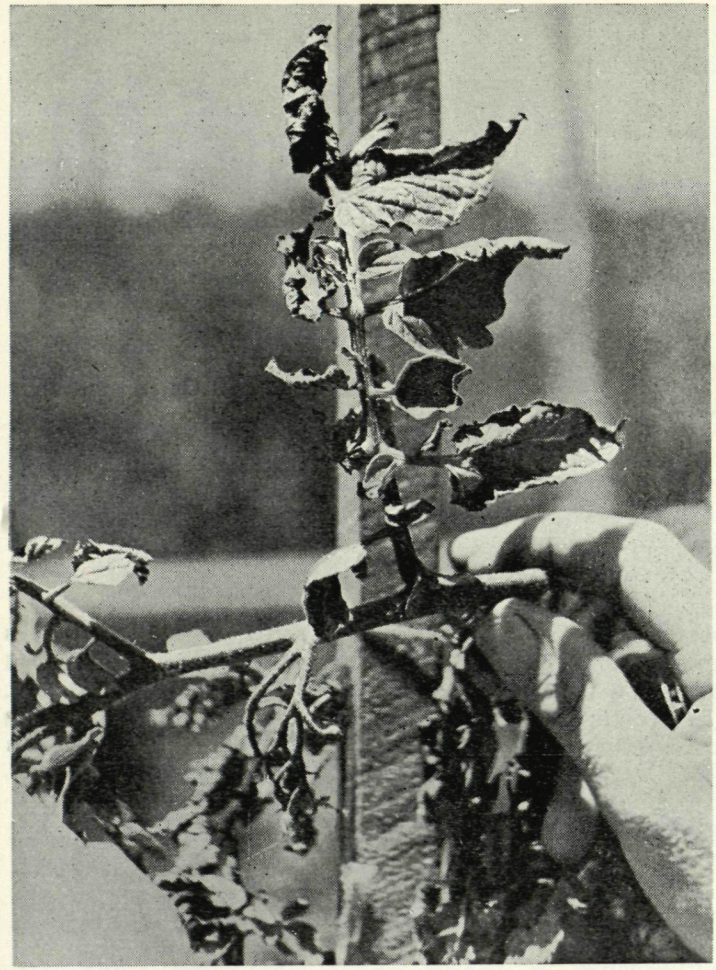

Fig. 2.—Single leaf (still attached to plant) at later stage of the disease. Note shrivelled leaflets on one side of leaf only, and marginal withering and uprolling of remainder

only gradually withers (Fig. 3). If such infected leaves are broken from the stem, a discolouration of the water-conducting tissue is visible, yellow at an early stage and brown at a more advanced stage of the disease.

When cut in section the stem shows definite browning of the water-conducting tissues extending into the pith which also becomes yellowed and finally dark brown. There is a tendency to mealiness and to the formation of pockets in the pith which finally becomes hollowed out. Browning and breakdowns of the pith is more definite at the nodes, and there is little evidence of the disease in the below-ground parts of the plant (Fig. 4, a, b, and c.)

During wet weather or when overhead sprinklers are used, whitish, round to oval, spots often appear on stems (Fig. 5A), leaf stalks, and sometimes on the leaves also. When the fruit develops it may also show this external spotting, white at first, then with a brownish and usually cracked centre (so-called bird's eye spotting) (Fig. 6). This symptom, when it occurs, is absolutely diagnostic of the disease.

In the later stages of disease development, the stems show elongated, whitish patches which may split longitudinally, giving cankers, although under our conditions canker formation appears to be rare (Fig. 7). Sometimes the small white spots on the stem (Fig. 5A) may split and develop into secondary cankers.

The fruit often drops prematurely and may show a browning beneath the calyx lobes. In badly-affected fruits the browning extends internally resulting in brownish discoloured areas and brown water-conducting strands (Fig. 5B.)

Fig. 3.—Young plant inoculated by means of needle prick with *C. michiganense* (three weeks after inoculation). Note withered leaves which hang down from the erect leaf stalks

Superficially bacterial canker resembles fusarium wilt but the one-sided withering of the leaves, the absence of leaf yellowing, the formation of pockets in the pith, and the fruit spots and stem cankers when present, serve to distinguish it from the latter trouble.

DEVELOPMENT OF THE DISEASE

The disease is caused by a bacterial parasite *Corynebacterium michiganense* and these minute organisms are generally introduced into new areas by means of infected seed or seedlings.

The bacteria invade the fruit of diseased plants through the water-conducting strands, with the result that the seeds become infected. Fruit invaded at an early stage may show internal discolouration (Fig. 5B) but it should be noted that fruit invaded at a later stage of development may ripen normally, and show little or no internal evidence of the disease to the naked eye.

However, the seeds saved from such fruit may give rise to the disease when planted.

When infected plants are present in either seed-bed or field, the disease may be spread in any of the following ways:—

(a) Handling of seedlings during transplanting, if a diseased seedling is handled prior to healthy ones.

(b) Pruning. This has been shown to be a very important means of spread. When laterals are pinched out by hand, sap containing the bacteria exudes, and this is transmitted by the fingers to the next plants which are handled. Even when only a few plants in the crop are initially infected, the disease is very rapidly transmitted to the remainder by this means unless precautions are taken. Most growers have noticed that within a fortnight or so of the first pruning, the disease has become very obvious throughout the crop even when previously they had been unaware of its presence. As a result of this, experiments have been conducted recently to study

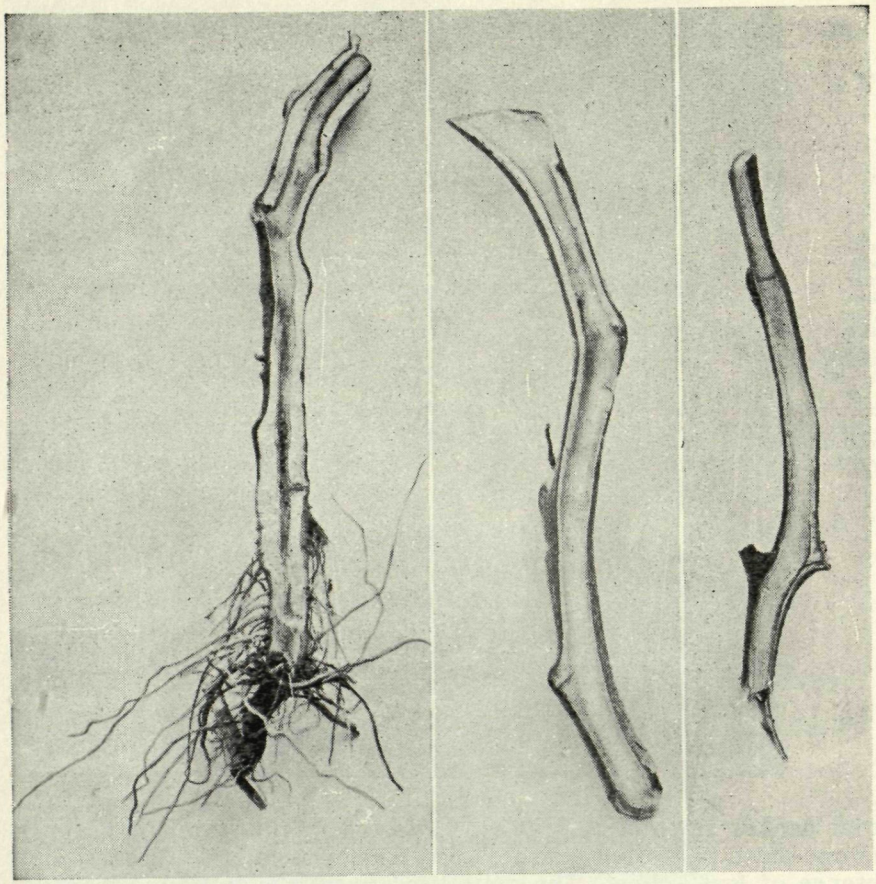

Fig. 4. — Longitudinal sections of stems
(a) Early stage, showing browned water-conducting strands in stem and leaf stalk
(b) Later stage showing in addition slight discolouration of pith
(c) Final stage with pith very dark and tending to break down with form cavilities.
N.B.—Widening of discolouration of nodes

means of reducing the spread by pruning. It has been found that hand pruning (as commonly practised by growers in this State) favours the spread of the disease as compared with knife pruning.

A further reduction can be obtained by sterilising the knife with Cetrimide disinfectant after pruning each plant (see control.)

(c) In the splash from sprinklers, rain, etc., especially if wounds are present on the plant. (This also

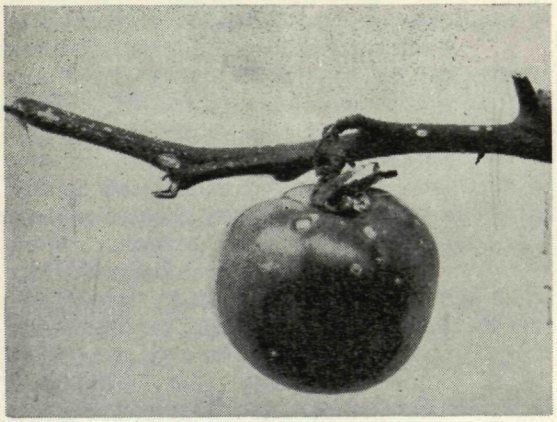

Fig. 5.—Portion of stem and attached fruit showing external whitish spots caused by splashing with water containing the canker organism

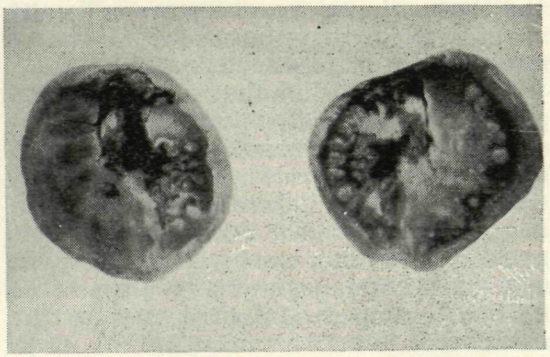

Fig. 6.—Longitudinal section of tomato fruit showing browning below calyx lobes, brown discoloured areas in pith and browned water-conducting strands due to presence of the disease

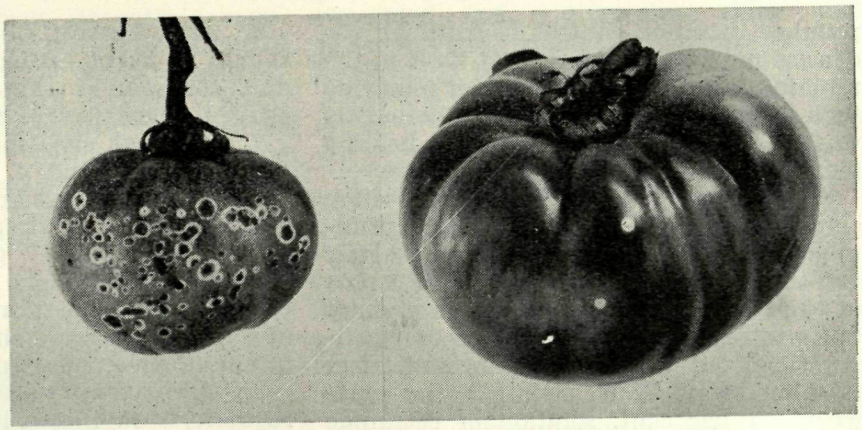

Fig. 7.—Fruit showing "bird's eye" spotting due to external infections with the canker organism. On left: badly infected fruit. Note white haloes and dark centres of spots. On right: early stage of spot

gives rise to the surface fruit spots which make fruit unsightly and lower its market value.)

(d) Observations also suggest that the disease can be transmitted by insects following feeding on infected plants.

CONTROL

1. Growers who intend to save their own seed should select disease-free plants for this purpose, as infected seed is an important source of primary spread.

2. Seed should be extracted by fermenting the pulped fruit without water for four days in a cool shady place. The fermenting material should be stirred night and morning to submerge pulp floating on the surface. This is not only an easy method of seed extraction but also some of the disease bacteria are killed during the fermentation period.

3. Finally, prior to planting, all seed, irrespective of its source, should be disinfected by steeping for 25 minutes in hot water plus formalin maintained at a temperature of 127° F. (Use one fluid ounce or two tablespoons of formalin to $2\frac{1}{2}$ gallons of water). After treatment, dry the seed as quickly as possible and when completely dry dust with an organic mercury dust (e.g. Cresan, Agrosan). This hot water treatment plus dusting also helps to control other seed borne diseases such as fusarium wilt, bacterial wilt, early blight and damping-off.

4. Plants which show definite symptoms of the disease at an early stage either in the seed bed or the field, should be removed and destroyed as soon as possible. If allowed to remain, they will serve as

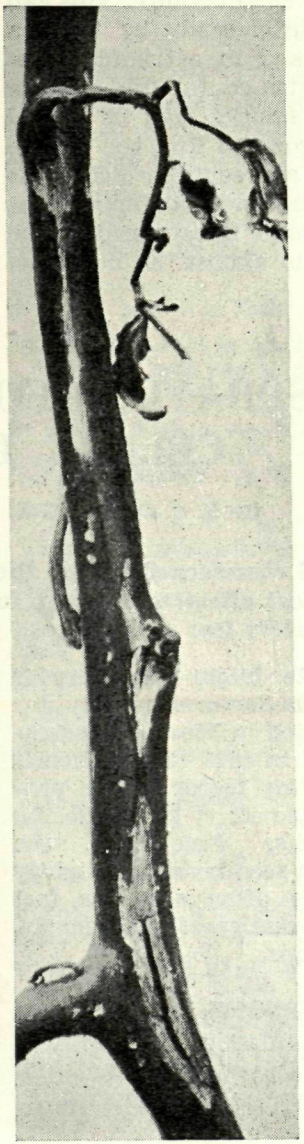

Fig. 8. — Stem of diseased plant showing elongated, light, sunken patches, which may split to form cankers, as in specimen. Canker formation appears to be rare under our conditions

primary infection centres from which the disease may spread in various ways to the remaining healthy plants. After removing such plants, the hands should be thoroughly washed in soapy water before healthy plants are handled.

5. For the reasons set out in the section concerning spread of the disease by pruning, growers are strongly advised to test out the following method on at least part of their crop. When pruning, use a sharp knife to remove laterals instead of pinching them out with the fingers and, after pruning each plant, disinfect the knife with a 1 per cent. solution of cetrimide (sold commercially as Cetavlon). This can be carried out quite easily by tying a plastic sponge soaked in cetrimide solution to the belt. A tin containing a gallon or so of the bulk solution can be placed at the end of the rows so that the sponge can be moistened as required. Growers who have tested this method report that once they have become accustomed to the use of a knife it is almost as quick as hand pruning.

6. After harvest, diseased crop residues should be burnt rather than ploughed in, and the ground should not be planted again to tomatoes for at least three years.

7. Seed bed sites should be changed at each planting, and if permanent wooden frames or seed boxes are used these should be disinfected by drenching with 2 per cent formalin (1 gallon commercial formalin in 49 gallons of water) or 2 per cent. bluestone solution (1 lb. in 5 gallons of water). Old stakes should also be dipped in one of these solutions.

8. Keep insect pests under control by regularly spraying with insecticides.

(Full details of a simple home made apparatus required for carrying out the hot water seed treatment are given in Advisory leaflet No. 1044 obtainable free of charge from the Department of Agriculture).

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COVER SPRAYING FOR THE CONTROL OF CELERY LEAF SPOT

By S. C. CHAMBERS, M.Sc., Plant Pathologist

INVESTIGATIONS commenced during the past autumn have indicated that Bordeaux 4:4:40 is the most effective of eight fungicidal preparations tested as cover sprays for the control of celery leaf spot.

Leaf spot or late blight of celery is incited by the fungus *Septoria apii* Chester and was first recorded in Western Australia at Osborne Park in 1923. Since then it has become a limiting factor in the production of marketable celery grown during the winter months. Frequently, the disease originates in seed beds and slightly affected transplants often serve as foci from which the disease spreads epidemically throughout crops.

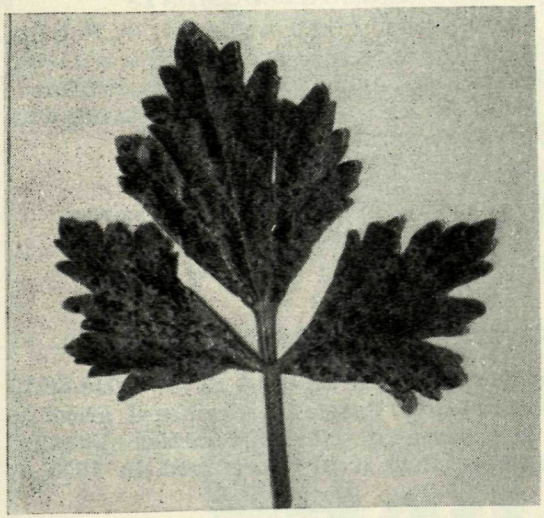
SYMPTOMS

Usually the disease first becomes evident on the older lower leaves of a plant and gradually spreads upwards and inwards to the younger foliage. On leaves it causes somewhat circular spots which seldom exceed $\frac{1}{8}$ in. diameter (see illustration). These are yellow to brown at first, but later become stippled in appearance and finally almost black, as large numbers of minute black fungal bodies (*pycnidia*) are formed in them. Coalescence frequently occurs when spots are very numerous, culminating in the partial or complete collapse of leaflets and leaves. Spots on stems tend to be elongated rather than circular.

EXPERIMENTAL

Although preventive spraying with a copper-containing fungicide has been suggested to growers in the past, no experimental work has been carried out

previously in this State. Recently, favourable results were obtained with some of the newer fungicides in New Zealand by Jacks (1955) and Jacks & Webb (1956). As a result, it was decided to evaluate some of the more promising of these materials under Western Australian conditions and to compare them with a standard copper-containing fungicide.



Leaf spots caused by the fungus *Septoria apii*

Method:—The trial was conducted on a property at Balcatta using portion of a crop transplanted on March 28, 1958.

The experimental design was a simple randomised block containing four replications of nine treatments and the component plots measured 25 links in length by 2 rows in width.

The fungicides tested as cover sprays were:—Bordeaux 4:4:40; Captan 2 lb.-100 gal.; Phygon 1 lb.-100 gal.; Thiram 1½ lb.-100 gal.; Vancide 2 lb.-100 gal.; Ziram 1½ lb.-100 gal. and Zineb 1½ lb.-100 gal.

Calcium caseinate (1 lb.-100 gal.) was used as a spreader for the Bordeaux mixture and Triton B 1956 (3-4 fl. oz.-100 gal.) was added to each of the remaining fungicides. Spraying was commenced on April 10, 1958, and continued at 10-14 day intervals until July 19, 1958.

An assessment of leaf spot incidence in relation to treatment was made on July 24, 1952. In order to do this, randomised samples of 100 leaves from each plot were examined and a numerical value was allotted to the condition of each leaf in accordance with Table I.

Table I.

CLASSIFICATION OF LEAF SPOT SYMPTOMS ON INDIVIDUAL LEAVES.

Class	Symptoms on Leaf	Numerical Evaluation
1	No visible symptoms	0
2	Less than four lesions per leaflet	1
3	More than four lesions per leaflet	2
4	Partial or complete collapse of one leaflet	3
5	Partial or complete collapse of more than one leaflet	4

The mean leaf value obtained for each plot was transformed to an $\sqrt{x}$ value during the analysis of results.

Results:—The final analysis of leaf spot incidence in relation to treatment is contained in Table II.

Table II.

EFFECT OF VARIOUS COVER SPRAYS ON INCIDENCE OF S. APII.

Fungicide	Evaluation of Leaf Spot Incidence	
	Mean Leaf Value	$\sqrt{x}$
Bordeaux	0·07	0·23
Phygon	0·10	0·29
Ziram	0·16	0·39
Zineb	0·27	0·51
Captan	0·30	0·55
Thiram	0·34	0·58
Vancide	0·63	0·79
Ferbam	0·74	0·85
Control (no fungicide)	2·51	1·58
Difference for Significance—		
5% level		0·16
1% level		0·22

During the trial, it was noted that plants sprayed with Phygon were retarded in growth and a paler green than normal.

DISCUSSION

The significant reduction in Septoria leaf spot following the regular application of fungicide emphasises the necessity for

routine spraying of winter grown celery. Of the eight materials examined in this trial Bordeaux mixture was significantly better than all others with the exception of Phygon. However the apparent retardation of growth by Phygon casts some doubt upon its commercial usage for celery.

On the other hand Bordeaux has the disadvantage of discolouring the foliage and this may detract from the market value of the produce. Because of this, further work is proposed using split schedules in which Bordeaux is followed by other fungicides before making a general recommendation to growers.

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Jacks, H., and Webb, A. J.,—A Note on Field Control of Celery Leaf Spot (*Septoria apii* Chester), N.Z. J. Sci. Tech. A38, 2: 129-31.

ACKNOWLEDGMENTS

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A NOTE ON THE OCCURRENCE OF STUNT DISEASE IN SUBTERRANEAN CLOVER

By H. L. HARVEY, B.Sc. (Agric.), Senior Plant Pathologist

THE stunt virus disease of subterranean clover, formerly referred to as "little leaf," was found during the winter of 1958 in the South Coastal agricultural areas at Esperance, Gibson and Gairdner River on subterranean clover varieties Bacchus Marsh, Dwalganup and Yarloop. Reports indicate that it also occurred in 1955 at Esperance.

In most of the affected paddocks, one or two per cent. of plants were diseased. In some, however, the incidence was higher than this and in one case about 90 per cent. of the plants were affected.

The first recorded occurrence of this disease was in N.S.W. (Grylls and Butler, 1956). It was subsequently reported from Tasmania (Wade, 1957) and Victoria (O'Loughlin, 1958.)

SYMPTOMS

As the name suggests, infected subterranean clover plants may become severely

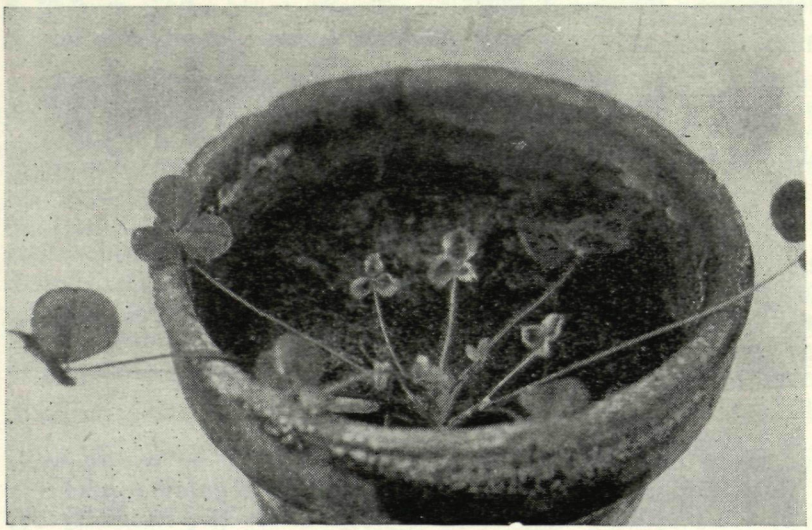

Fig. 1.—Subterranean clover seedling showing large older leaves and stunted young leaves which emerged after virus infection had occurred

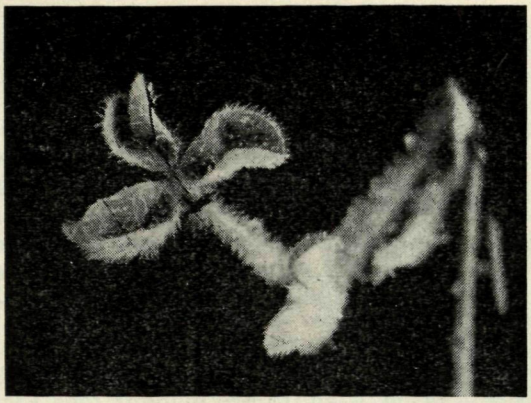

Fig. 2.—Young leaf (enlarged) only partly unfolded, showing typical malformation and marginal yellowing associated with the stunt disease

stunted. Leaves which have developed prior to infection grow to a normal size, but often turn red later. Those which emerge after infection are extremely small, distorted in shape and pale coloured (Fig. 1). They are very slow to open out and for a long time leaflets remain folded upwards along the midrib with undulating pale green to yellow margins (Fig. 2). This marginal yellowing usually persists after the leaflets unfold, by which time they are noticeably puckered. Leaf stalks are shorter than in normal plants. These abnormalities of shape, size and colour contrast strongly with the large, dark green flat leaves of healthy subterranean clover plants (Fig. 3.)

As the percentage of affected plants increases, so the total bulk of clover pasture will be reduced. There is preliminary evidence, also, that seed setting is impaired but the full significance of this aspect of the disease has not yet been assessed.

CAUSE AND TRANSMISSION

The disease is caused by a virus shown by Grylls and Butler (1956) to be transmitted by two species of aphides (*Aphis craccivora* and *Myzus persicae*). A colony of black aphides which was found on the diseased subterranean clover from Esperance and which has been tentatively identified as *A. craccivora,* readily transmitted the disease when transferred to healthy Bacchus Marsh test plants. Aphid transmission is the only known natural means of spread of the stunt virus.

CONTROL

No recommendations can yet be made for the control of subterranean clover stunt. However, the disease-resistance found by O'Loughlin (1958), in Tallarook and some European varieties of subterranean clover may be useful for breeding other suitable stunt-resistant varieties.

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Wade, G. C. (1957). Tas. J. Agr., 28: 64-69.

O'Loughlin, G. T. (1958). Vic. J. Agr., 56: 385-387.

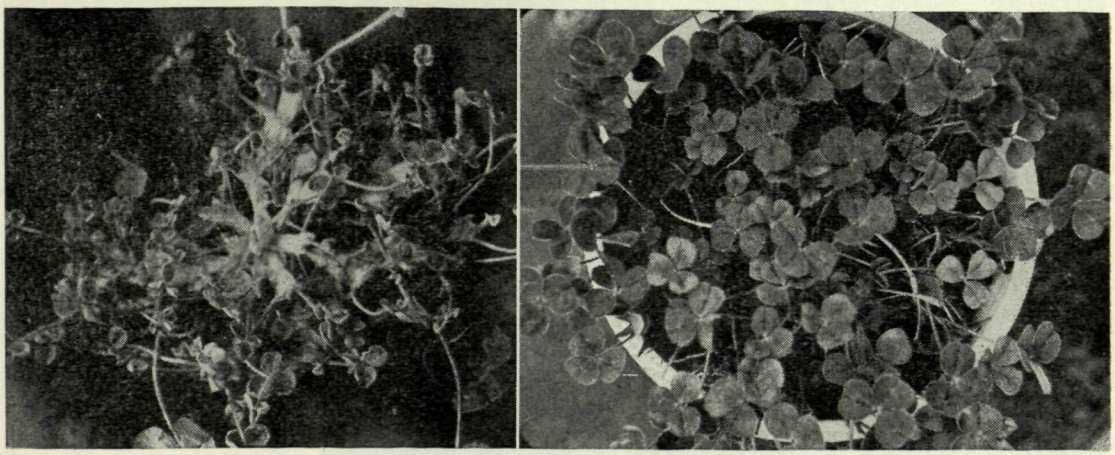

Fig. 3.—Left:—Small malformed, discoloured leaves on stunt-infected subterranean clover. Right—Normal foliage on healthy subterranean clover