THE INFLUENCE OF CHEMICAL MANURES UPON 'WHITE ROT' OF *ALLIUM*

BY R. P. ASTHANA, M.SC., D.I.C., PH.D. (LONDON), F.A.SC.

(Mycologist to Government, C.P. and Berar, Nagpur)

Received April 18, 1945

WHITE rot of *Allium* caused by *Sclerotium cepivorum* Berk. is a serious disease of *Allium cepa* Linn. (onion), *A. fistulosum* Linn. (Welsh onion), *A. porrum* Linn. (leek), *A. sativum* Linn. (garlic), and *A. ascolonicum* Linn. (shallots), but *A. cepa* Linn. suffers the most. The primary symptom of the disease is wilting with yellowing of the foliage. First of all the oldest leaves turn yellow and fall over, followed by others which also collapse. Such plants will come off the ground by even a gentle pull and on examination it would be found that almost all the roots are destroyed. The fungus persists during winter in soil by sclerotia which germinate late in the spring and thus bring about the infection of the new crop. The sclerotia can remain viable in soil for more than five years. In European countries and America it becomes very destructive malady as the fungus thrives best at moderately cool temperatures with moderate soil moisture. Sowing onions year after year in the infected soil aggravates the disease. The principal means of wide dissemination of the fungus is the transportation of infected bulbs or plants, or by containers of the same.

The disease is of widespread occurrence. Berkeley[1] first observed the fungus and named it *Sclerotium cepivorum* Berk. Voglino[11] recorded severe attack of leeks in Italy and renamed the fungus *Sphacelia allii*. Cotton and Owen[5] reported that the disease caused considerable damage to onion crops, shallots were markedly resistant and leeks did not appear to suffer. Caballero[4] reported considerable damage to garlic in Spain. Walker[12] found that the disease occurred on onion, Welsh onion, leek, garlic and shallot in Europe and America. Nattrass[7] reported the occurrence of the disease from Egypt. Du Plessis[6] gave an account of the disease from South Africa and reports that disinfection of soil by formalin, heat or mercuric chloride are impracticable on a large scale though in laboratory test the sclerotia succumbed to these treatments. Onion varieties showing marked resistance to *S. cepivorum* have been developed at Manchester. Nattrass[8] reported the occurrence of the disease in Cyprus and suggests that sets should only be planted from disease-free areas and cultivation of the different

species of *Allium* should be discontinued for 8 to 10 years. Bremer[3] reports the presence of the disease in Germany and also recommends a well-regulated rotation in which onions are excluded from infested fields for at least 8 to 10 years. Ogilvie and Hickman[9] found the disease widely distributed in Bristol province mainly on White Lisbon Spring onion. A soil application of a proprietary organic mercury compound in dust form containing hydroxymercuri chlorophenol with 20 per cent. organically combined mercury, before sowing, gave 56·8 and 17·9 per cent. infection at two localities respectively against averages of 86·7 and 90·4 per cent. for the corresponding untreated control plots. Ogilvie, Croxall and Hickman[10] found that early autumn sowings of onions were more severely affected by white rot than were late sowings. Brandão[2] has given popular notes on the symptoms and control of the disease affecting garlic in Brazil.

A series of experiments were carried out at Slough during the summers of 1931 and 1932 to find the effects of certain chemical manures on the incidence of the disease. All through the laboratory and field experiments 'White Spring Lisbon' onion seeds were used. Other varieties when used have been mentioned at the appropriate places.

A plot 44 × 6 ft. was divided into six equal plots, A–F, which were manured each year with superphosphate, potassium sulphate and ammonium sulphate in ratio of 6:1:2 (A), 6:0:2 (B), 6:4:0 (C), 6:4:2 (D), 6:0:8 (E), and 0:0:0 (control) respectively. Six hundred seeds were sown in each plot with (*a*) uninoculated (control) and (*b*) inoculated with *Sclerotium cepivorum*.

The same piece of ground has been used during the previous year for certain tests with *S. cepivorum* and as it turned out, had become contaminated to some extent with that fungus. The result was that both the control rows and the rows inoculated with *S. cepivorum* showed seedlings being killed off. A study of these by the ordinary cultural methods proved that the active fungus was *S. cepivorum*. The experiment was thus to some extent vitiated, but certain indications were forthcoming. These are given in Tables I and II.

Table I gives the results obtained during the first year.

The controls remained comparatively free of infection except plot F.

Results from the above table show that there was very heavy attack by *S. cepivorum* in plots A, B, E and F. It is suggestive that the two plots in which little attack took place (C and D) were those with high potash manuring.

TABLE I

Superphosphate, K_2SO_4 and $(NH_4)_2SO_4$ ratio in the plots	Treatment	Percentage of germination	Percentage of healthy plants	
			After 40 days	After 63 days
A 6 : 1 : 2	*S. cepivorum* Control	46·7 73·5	17·0 73·5	1·2 71·5
B 6 : 0 : 2	*S. cepivorum* Control	54·7 71·8	37·6 71·8	13·1 70·8
C 6 : 4 : 0	*S. cepivorum* Control	62·4 68·8	59·3 68·8	59·3 68·8
D 6 : 4 : 2	*S. cepivorum* Control	66·9 67·8	65·2 67·8	65·2 67·8
E 6 : 0 : 8	*S. cepivorum* Control	53·7 71·3	29·4 71·3	5·4 69·3
F 0 : 0 : 0	*S. cepivorum* Control	22·0 69·0	2·4 59·0	0·0 54·0

The results obtained in the same series of plots during the next year are given in Table II.

TABLE II

Superphosphate, K_2SO_4 and $(NH_4)_2SO_4$ ratio in the plots	Treatment	Percentage of healthy plants	
		After 40 days	After 90 days
A 6 : 1 : 2	*S. cepivorum* Control	17·3 24·3	8·1 20·5
B 6 : 0 : 2	*S. cepivorum* Control	16·8 25·0	14·6 16·5
C 6 : 4 : 0	*S. cepivorum* Control	24·3 22·6	13·5 18·6
D 6 : 4 : 2	*S. cepivorum* Control	16·0 18·0	8·6 13·8
E 6 : 0 : 8	*S. cepivorum* Control	11·3 15·8	6·0 7·1
F 0 : 0 : 0	*S. cepivorum* Control	16·5 25·0	4·6 15·1

These results show that the control plots were now seriously infected, and for that reason no conclusion could be drawn.

An experiment of a similar type was carried out in which onion seed was sown uninoculated or with *S. cepivorum* on plots which were manured in the following manner:—

A. Superphosphate at the rate of 6 cwt. per acre.

B. Potassium sulphate at the rate of 2 cwt. per acre.

C. Ammonium sulphate at the rate of 2 cwt. per acre.

D. No manure.

A double series of plots of this kind was prepared, the one in dry light land and the other in rather peaty wet land. The results obtained in the two experiments are shown in Tables III and IV. In each plot 400 seeds were inoculated by *S. cepivorum* and the same number were sown as control.

TABLE III

Dry light soil

Plots and manuring	Percentage of healthy plants	
	S. cepivorum	Control (uninoculated)
A. Superphosphate	28·8	44·5
B. Potassium sulphate	34·5	45·0
C. Ammonium sulphate	29·0	40·0
D. No manure	25·0	43·0

TABLE IV

Peaty wet soil

Plots and manuring	Percentage of healthy plants	
	S. cepivorum	Control (uninoculated)
A. Superphosphate	17·6	61·0
B. Potassium sulphate	20·0	66·4
C. Ammonium sulphate	20·0	67·2
D. No manure	42·0	70·0

Both tables indicate considerable attack by *S. cepivorum*, but it is doubtful if any specific value can be attached to any of the manurial treatments as regards checking the disease.

The diminished attack on plots with high potash manuring indicated in Table I appeared to run parallel with greater resistance of the bulb tissues

to invasion. Ten healthy bulbs were selected from each of the plots, and comparable inoculations by *S. cepivorum* on the scales of these were carried out in the laboratory. The average amounts of attack produced after 12 days were as in Table V.

TABLE V

	Average area of rot caused by *S. cepivorum* on onions from different plots					
Plot	A	B	C	D	E	F
Average rot area (in cm.)	1·5	1·2	0·5	0·8	1·6	2·0

It is noteworthy that the bulbs derived from plots C and D (compare Table I) showed considerably less attack than the others.

An experiment on the effect of liming on the incidence of the disease was also carried out. Three treatments were tested, (*a*) no lime, (*b*) lime at the rate of 2 tons per acre, and (*c*) lime at the rate of 5 tons per acre. Each plot was duplicated. The results observed after 50 and 110 days are shown in Table VI.

TABLE VI

Plants (Numbers)	Days	Limbux 5 tons per acre.		Limbux 2 tons per acre		No lime	
		Inoculated by *S. cepivorum*	Uninoculated	Inoculated by *S. cepivorum*	Uninoculated	Inoculated by *S. cepivorum*	Uninoculated
Autumn sown onion seedlings (30)	50	28	30	26	30	30	30
	110	26	30	25	30	20	30
"White Lisbon" onion seeds (300)	50	170	189	163	174	79	172
	110	142	189	130	172	26	172
"Blood Red" onion seeds (300)	50	115	103	104	133	122	138
	110	93	99	98	131	86	135
"Musselburgh" leek seeds (300)	50	175	189	202	206	176	185
	110	155	194	167	205	158	184
Shallots (30)	50	29	30	28	29	28	30
	110	28	29	28	29	27	30

Here it will be seen that to a marked extent a control of the disease 'white rot' of Autumn-sown "Lisbon" onion seedlings or "White Lisbon" seeds is obtained by liming at the rate of 2 to 5 tons per acre. Other species of *Allium* are comparatively not so susceptible to the attack of *S. cepivorum*,

As a matter of interest it may be added that the average weight of onion bulbs was considerably affected by the different manurial treatments in the case when the experimental plot was on light land, but where the experiment was carried out on dark peaty soil, no significant difference was seen. Sample figures are given in Tables VII and VIII.

TABLE VII

Sandy light land

	Manuring ratio of Superphosphate : Potassium sulphate : Ammonium sulphate					
Ratio	6 : 1 : 2	6 : 0 : 2	6 : 4 : 0	6 : 4 : 2	6 : 0 : 8	0 : 0 : 0
Average rate of onion bulbs after 25 weeks (in gm.) ..	42	50	22	50	73	20

TABLE VIII

	Average weight of onion bulbs after 15 weeks	
	Sandy light soil gm.	Dark peaty soil gm.
Superphosphate	4	7·0
Potassium sulphate	5	8·2
Ammonium sulphate	21	7·5
No manure	9	6·0

It will be observed from the above two tables that on the sandy light land the average size of the bulbs showed a marked response to nitrogenous manuring.

My grateful thanks are due to Professor W. Brown for his valuable suggestions and directions.

SUMMARY

1. High potash manuring showed some decrease in the attack of *Sclerotium cepivorum* on onions. This diminished attack appears to run parallel with greater resistance of the bulb tissues to invasion.

2. There was an indication from plot experiments that liming reduced considerably more the amount of 'white rot' of onion seedlings than the potash manuring.

3. The average weight of onion bulbs was considerably affected by different manurial treatments. On sandy light land, nirtogenous manuring showed a marked increase in the weight and size of the bulbs.

References

1. Berkeley, M. J. .. *Ann. and Mag. Nat. Hist.*, 1841, **6**, 355–65.
2. Brandão, J. S. .. *Bol. Minist. agric. Riode J.*, 1942, June 6.
3. Bremer, H. .. *Nachrichtenbl. Deutsch. Pflanzenschutzdienst.*, 1934, **14**, 37–38.
4. Caballero, A. .. *Bol. de la R. Soc. Esp. de Hist. Nat.*, 1922, **22**, 210–12.
5. Cotton, A. D., and Owen, M. N. *Jour. Board of agric. of Great Britain*, 1919–20, **26**, 1093–99.
6. Du Plessis, S. J. .. *Farming in South Africa*, 1932, **7**, 112–14.
7. Nattrass, R. M. .. *Min. agri. Egypt Tech. and Sci. Service (Plant Protection Section) Bull.*, 1931, No. **107**, 109.
8. ———— .. *Cyprus agri. Journ.*, 1933, **8**, 98–100.
9. Ogilvie, L., and Hickman, C. J. *Rep. agric. hort. Res. Sta. Bristol*, (1937), 1938, **9**, 96–109.
10. ———, Croxall, H. E., and Hickman, C. J. *Ibid.*, (1938), 1939, **10**, 91–97.
11. Voglino, P. .. *Staz. Sper. agr. Ital.*, 1903, **36**, 89–106.
12. Walker, J. C. .. *Phytopath.*, 1924, **14**, 315–22.