THE EFFECT OF CHEMICAL DIP TREATMENTS ON THE CULTURE OF CROFT LILIES 1

EFFECT ON CONDITION OF ROOTS

by

E. C. Gasiorkiewicz and H. E. White*

*Assistant Professor Botany, University of Massachusetts Waltham Field Station, Waltham, Massachusetts, and Professor of Floriculture, University of Massachusetts, Amherst, Massachusetts, respectively.

Inquiries from growers about the causes for poor growth, lack of uniformity and deformed buds in Easter lilies (lilium longiflorum, Thumb) have increased during the past three years. Diagnostic isolations from specimens in Massachusetts confirmed the presence of three root rotting organisms, Fusarium, Rhizoctonia and Pythium. The source of these pathogens may be:

1. Soil inhabiting organisms in native soils.

2. Importation on diseased bulbs.

Steam sterilization, i.e. steam pasteurization at 180° F for ½ hour, of potting soils in an effective method to eliminate the causal organisms from native soils. Strict sanitation practices of sterilized pots, clean benches, protect against recontamination of soils.

The second source of the pathogen was confirmed by reisolation of the causal organisms from lily shipments prior to planting.

The predominant symptoms associated with the infestation of a lily bulb is a failure of root formation at the bottom of the pot or a severe root rotting. The objective of the experiment was to evaluate the effects of preplanting chemical disinfection treatments applied to lilies for control of root rot and growth of the lily plant.

This report will cover the results obtained on the underground part of the lily plant.

Methods

Bulbs - Bulbs were obtained from two sources in two sizes. The Amherst source consisted of 7-8 ins. bulbs and this was divided into two lots for planting at Amherst and Waltham. The Waltham 8-9 ins. bulbs were obtained from one source and these were all used at Waltham.

Soil - The base soil used at Amherst was unamended field soil. Samples of these soils were sterilized by steam pasteurization for one hour at 180° F.

The Waltham tests were conducted in a 3:1 mixture of loam and peat moss. All soil used at the Waltham field station was steam pasteurized in ground beds in the fall prior to storage. The soil used in this study had been stored about three months. Because of recontamination this soil was sterilized by electric pasteurization in a Dillon Soil Pasteurizer set at 180° F for two hours. In the tables and text, the stored, once-pasteurized, soil is referred to as unsterilized to differentiate it from the soil that had been sterilized immediately prior to planting.

Treatments - All the chemicals used are listed in Table 1. and were prepared in earthenware crocks and all replicates were treated at the same time. Treatments were split into lots for sterilized and unsterilized soil plantings. All plantings in sterilized and unsterilized soils were performed by different operators. All treatments at Amherst were replicated twelve times and at Waltham, nine times. Single plant units were used as replicates and were randomized in the greenhouse.

Handling - Production benches were V bottom concrete brnches filled with pea stone. All benches and pots used were steam sterilized for 45 minutes at 180° F.

Five inch clay pots were used for all treatments. Sterilized clay pot fragments and ½ inch of pea stone were placed in the bottom of each pot to provide good uniform drainage.

About an inch of prepared soil was placed over drainage material followed by positioning of bulb and covering with appropriate soil to within ½ inch of the lip of the pot.

All pots were spaced four inches between rows and three inches between pots to minimize contamination.

Fertilization with soluble fertilizer (15-30-15) was initiated at six-inch height and was continued on a bi-weekly schedule for the duration of the experiment.

Plants at Amherst were grown at 60° F. night temperatures and the Amherst bulbs (7-8) used at Waltham were grown at 50° F. for 1 month and were transferred and finished at 60° F. The Waltham bulbs (8-9) were grown at 60° F. for the duration of the project.

The Amherst experiment was planted on December 26, 1956. At Waltham the 8-9 bulbs were planted on December 26, and the 7-8's shipped from Amherst were planted on December 28.

The root rot and root system evaluations were made in April 12, 1957 about 106 days after planting when plants were in bloom. All plants were removed from the pots and an evaluation of the root growth in the soil ball was made. This evaluation is referred to as a soil ball index by which the root growth in an intact soil ball was rated as 3. for abundant growth, 2. moderate, and 1. for the least growth. The index was comparative in the sample scored. Standardization of the indexing was achieved by reference to kodachrome illustrations of established categories.

The roots were evaluated for root rot following removal of soil, from all plants, by washing. The root rot was evaluated on a basis of 1 to 5 with the most severe rooting occurring in the highest category and is referred to as the root rot index.

Results

Tables 2, 3, and 4 show the effect of chemical dip treatments on the condition of roots in an intact soil ball referred to as the soil ball index and the root rot index.

The data in Table 2 show that the root rot index was not affected by the treatments when comparison was made of similar treatments in sterilized and unsterilized soils There were no significant differences between treatments and checks in either soil.

The soil ball index was significantly different between the Fulex ADO treatment and checks in both sterilized and unsterilized soil. The Spergon + Terrachlor treatment was equal to the check. There were significant differences between the other treatments and checks in the sterilized soil. In the unsterilized soil all treatments were superior to the check.

The root rot index data in Table 3 shows that the Wisconsin and Bloeckner combination treatments, Thioneb, Fe Omadine 1565, and Fe Omadine + Terraclor were significantly different and superior to the checks. In unsteamed soils, Gloeckner's and Fe Omadine were significantly superior to the check.

The soil ball index data in Table 3 show that there were no significant differences between treatments in steamed soils; no significant differences between similar treatments in both sterilized and unsterilized soils.

The data in Table 4 show that the amount of root rot was significantly different between sterilized and unsterilized soils regardless of treatment except for the Terraclor treatment. In steamed soils Cu Omadine + Terraclor, was significantly different from the check in that root rot was more severe.

The ineffectiveness of the treatments to control root rot in unsteamed, field soil is indicated in that the Captan, Captan + Terraclor + Cu Omadine + Terraclor and Oxyquinoline citrate were significantly different from the check.

There were no significant differences between treatments or between treatments and checks in either steamed or unsteamed soil.

Discussion and Conclusion

The results of this experiment indicate that insurance of a productive crop is obtained when steamed soil and/or chemical dip treatments were used. Three types of soils used in the experiment typify the standard greenhouse operations. The unamended, field soil is used by growers with the argument that such soils are "safe" because lilies have not been grown in them. Potted plant growers frequently steam sterilize soil before storing for later use. Very seldom are precautions taken to prevent re-contamination of stored soil by organisms disseminated from growers' shoes, work tools, flats, etc. This was the second type of soil used in this report. More careful growers resterilize stored soil prior to use for potted plants.

The best treatment in the unamended soil plantings (Table 4) was the combination of steaming and oxy-quinoline sulfate for 30 min. The steamed-soil, check treatment was second best indicating that steaming along can be very effective in controlling root rots. In general all the chemical treatments plus steamed soil were superior to chemical treatment and unsteamed soil.

There was very little difference between root rot present in once-steamed and twice-steamed soils. This indicates that steaming is beneficial in removing the disease organism from native soils (Table 2). However, this statement may not always be true because of a variation in the source of bulbs. In Table 3, bulbs from the same source as those in Amherst (Table 4) planted in once-sterilized, stored soil and soil re-sterilized, prior to planting showed significant differences in root rot only in the once-sterilized, stored soil. These results indicated the effectiveness of steaming in checking root rot. However, the use of chemical dips in once-sterilized, stored soil was very beneficial in effecting control of root rot almost equivalent to twice-steamed soils.

Thefollowing conclusions can be made from these tests:-

1. Steaming of native soils aids in the elimination of the disease-producing organisms.

2. Stored, steamed soils are not always safe because of recontamination.

3. Preplanting chemical dip treatments were highly effective in reducing root rot regardless of the type of soil used.

4. The condition of the soil ball does not reveal the extent of root damage on the bulb.

Acknowledgements

The croft lilies used for these experiments were kindly supplied by S. S. Skidelsky Company and Vaughan's Seed Company. The chemicals used for the treatments were contributed by the following: Olin-Mathieson Co.; Stauffer Chemical Co.; E. I. DuPont de Nemours & Co.; Fuller System, Eli Lilly Co.; Midvale Chemical Co.; California Spray-Chemical Co.; Union Carbide Co.; Mallinckrodt Chemical Works; U. S. Rubber; Naugatuck Chemical Division; and Niagra Chemical Division of the U. S. Food Machinery Co.

TABLE 1. Chemicals used as dip treatments for controlling root rots in Croft lilies, Amherst and Waltham, Mass., 1956.

Name	Active Principle	Rate
Captan 50W	N-(trichloromethylthio)-4-cyclohexene-1,2-dicarboximide	2 lbs:100 gal.
PCNB 75WP	Pentachloronitrobenzene	1 lb:100 gal.
Captan + PCNB	as above	as above
Cu Omadine #1562	opperhydroxypyridinethione	1.5 lb.:100 gal.
Cu Omadine + PCNB	as above	as above
Chloranil (spergon)a/	Tetrachloro-p-benzoquinone	1 oz:6 qts.
Chloranil + PCNB b/	as above	as above
Oxquinoline sulfate	Oxyquinoline sulfate	1:1600 sol.
Vancide Z-65	Zinc derivative of 2-mercapto-benzothiazole	1.5 lb:100 gal.
Formaldehyde	Formalin 40%	1:50 sol.
Thioneb 50W	Polyethylene thiuram sulfide	2 lb:100 gal.
Fe Omadine 50W	Iron mercaptopyridine oxide	2 lb:100 gal.
Methiolate	Sodium ethylmercurithiosalicylate	1:1000
Fe Omadine + PCNB	as above	as above
Citrox	Oxyquinoline citrate	3 lbs:500 gal.
Mylone	Tetrahydro-3,5-dimethyl-2H-1,3,5-thiadiazine-2-thione	1 lb:100 gal.
Fulex ADO	Hydroxyquinoline sulfate 25%	1:4000
Wisconsin 1956		
Parathion	O,O-Diethyl-O-p nitrophenyl thiophosphate	11.2 g
Ferbam 76%	Ferric-dimethyldithiocarbamate	18.6 per 2 gal.
Lysol	Orthohydroxy diphenyl Alcohol & Cresylic Acid 7.2% by volume	2 T
Gloeckner 1956		
Terrachlor	Pentachloronitrobenzene 75W	14 gm per 2 gal.
Ferbam 76%	Ferric-dimethyldithiocarbamate	14 gm

a/ All treatments were 30 minutes immersions except Chloranil. Chloranil treatments were of 5 minutes duration.

b/ A two dip combination - Chloranil 5 minutes; PCNB, 25 minutes.

TABLE 2. The effect of treating Croft lily bulbs (8-9's) with fungicides on the development of root rot and soil ball index, Waltham, 1957.

Treatment	Root Rot Index		Soil Ball Index	
	Steamed Soil	Unsteamed	Steamed Soil	Unsteamed
Captan 50W	3.44	3.44	2.97	3.0
Terraclor 75W	3.0	2.88	2.97	2.94
Captan - Terraclor	2.78	2.78	2.92	3.0
Cu Omadine #1562	2.78	3.22	2.97	3.0
Cu Omadine - Terraclor	3.11	3.78	2.94	3.0
Spergon (chloranil)	3.0	3.67	2.97	2.97
Spergon - Terraclor	3.22	3.11	3.0	3.0
Crag 974 (Mylone)	3.67	3.67	2.97	3.0
Oxyquinoline sulfate	3.78	3.55	2.92	2.94
Fulex ADO	3.78	3.0	2.83	3.0
Vancide Z-65	3.0	3.55	2.97	3.0
Roots removed	2.89	4.0	2.89	2.89
Checks	3.0	2.67	2.89	2.77
A difference between means of: is significant with odds of 19:1	.801		.118	

1/ average of 9 bulbs per treatment.

TABLE 3. The effect of treating Croft lily bulbs (7-8) with fungicides on the development of root rot and soil ball index, Waltham, 1957.

Treatment	Root Rot Index Steamed Soil	Root Rot Index Unsteamed	Soil Ball Index Steamed Soil	Soil Ball Index Unsteamed
Wisconsin	3.78 a/	3.0	2.03	2.67
Gloeckner	3.33	2.44	2.39	2.94
Formaldehyde	3.33	2.89	2.55	2.58
Thioneb	3.22	2.78	2.47	2.89
Fe Omadine #1563	2.78	2.55	2.86	2.94
Merthiolate	0.0 b/	0.0	0.0	0.0
Fe Omadine - Terraclor	2.0	2.78	2.97	2.89
Check	3.39	3.11	2.72	2.75
A difference between means of: is significant with odds of 19:1	.401		.776	

a/ Average of 9 replicates per treatment.

b/ Material phytotoxic, caused emergence failure. Not included in analysis.

TABLE 4. The effect of treating Croft lily bulbs (7-8) with fungicides on the development of root rot and soil ball index, Amherst, 1957.

Treatment	Root Rot Index Steamed Soil	Root Rot Index Unsteamed	Soil Ball Index Steamed Soil	Soil Ball Index Unsteamed
Captan	2.92 a/	4.42	2.31	1.59
Terraclor	2.83	3.33	2.71	1.44
Captan - Terraclor	2.75	4.33	2.75	1.48
Cu Omadine #1562	2.50	4.42	2.81	1.27
Cu Omadine - Terraclor	3.16	4.00	2.35	1.58
Oxyquinoline sulfate	1.50	4.16	2.77	1.35
Oxyquinoline citrate	2.75	4.50	2.73	1.25
Check	2.26	3.36	2.48	1.23
A difference between means of: is significant with odds of 19:1	.811		1.606	

a/ average of 9 bulbs per treatment.

PART II

The data presented here is concerned with dip treatments of Croft Lily bulbs with a number of different chemicals and their effect on plant growth, Data pertaining to pathogens isolated or concerned and pathological aspects of the use of the chemical dip treatments is presented in another paper designated as Part I.

Methods and Materials

This experiment was conducted during 1956-1957 with Croft lily bulbs in preparation for flowering at Easter 1957. The two sizes of bulbs used were 7-8, 8-9 inch grades. The experiment was divided into three parts as shown in Tables 1, 2 and 3. Two groups of bulbs were treated with chemicals and grown at Waltham and one group treated and grown at Amherst.

In Table I, Waltham, bulbs of 7-8 inch size were treated with the following chemicals: Gloeckner formula (Captan + Fermate), Wisconsin formula (Parathion + Fermate + Lysol), Formaldehyde, Thioneb 50W, Omadine 1565, Omadine 1663 + PCNB, with checks. The dilution rate for the chemicals and the dip or soak period are discussed in Part I. Nine bulbs were used in each treatment and planted in 5 or 6 inch clay pots between December 27 and 28. Treated bulbs were grown in steamed and unsteamed soil.

Table I
The Effect of Different Chemical Treatments of Croft Lily Bulbs (7-8 inch size) on Plant Growth
Waltham-Data

	Emergence number days from planting — Soil steamed	not	Number days to bloom - average — Soil steamed	not	Average plant height in inches — Soil steamed	not	Number flower buds per plant average — Soil steamed	not	Scorch lesions per plant - average — Soil steamed	not
Gloeckner formula	37	37	115	116	12.54	13.27	2.44	3.44	4.77	3.22
Wisconsin formula	37	32	116	113	13.66	12.83	3.11	3.00	4.33	6.22
Formaldehyde	34	41	117	131	12.38	12.33	2.22	2.11	3.12	3.44
Thioneb 50W	39	35	115	141	12.66	13.05	3.44	3.55	7.11	5.66
Omadine 1565	35	38	116	116	12.55	13.16	3.11	3.55	3.12	2.77
Omadine 1563+PCNB	37	36	115	115	14.27	12.66	3.33	2.88	5.88	9.00
Total	219	219	694	732	78.06	77.30	17.65	18.53	28.33	30.31
Average	36.50	36.50	115.66	122	13.01	12.88	2.94	3.17	4.72	5.05
Checks	36	40	116	115	12.83	12.44	3.55	3.22	3.33	5.11

The Amherst chemcial treatments, Table 2 were as follows: 30 minute dip treatments, Captan 50W (9.08 gms.) per gallon of water; Terrachlor 75W (4.54 gms.) per gallon; Terrachlor + Captan (4.54 + 9.08 gms.); Oxyquinoline sulfate (1 tsp.); Oxyquinoline citrate (1 tsp.) per 3 gallons; Vancide Z-65 (6.81 gms.) per gallon. A 5 minute dip of Spergon (1 oz.) to 6 quarts water; Spergon (1 oz.) for 5 minutes plus Terrachlor (4.54 gms.) per gallon for 25 minutes. Twelve bulbs treated with each chemical were planted in steamed and unsteamed soil with controls.

In Table 3, Waltham, the following chemicals were used: Captan 50W, Terrachlor 75W, Captan + Terrachlor, Omadine 1562, Omadine 1562 + Terrachlor, Spergon, Spergon + Terrachlor, Crag 975, Oxyquinoline sulfate, Vancide Z-65 and FX-ADO. Nine bulbs were used in each treatment, using steamed and unsteamed soil. Also in this series 2 lots of 9 bulbs each had roots removed, but received no chemical treatment and were grown in steamed and unsteamed soil.

All lots of treated bulbs were fed, biweekly, with a complete soluble fertilizer as a liquid feed. Soil when steamed was treated at 180° F. for one hour.

The group of treated bulbs in Table I, Waltham, were grown for one month at 50°F. then finished to flowering stage at minimum temperature of 60° F. In Tables 2 and 3 all bulbs treatments were grown at a minimum temperature of 60° F. to flowering stage.

Plant height measurements were made from surface of the soil to the base of the peduncle. Tip burn or

Plant height measurements were made from surface of the soil to the base of the peduncle. Tip burn or leaf scorch lesions on leaves of plants were recorded weekly and a final count made at time of bloom. At Amherst each lot of 12 bulbs used in chemical treatments were weighed and the weight of each lot of bulbs adjusted so the total weight per lot varied not more than 1½ to 2 ounces between lots.

Experimental Results

Tables 1, 2 and 3 show the effect and relation of chemical dip treatments on shoot emergence, number days to bloom, final plant height, number of buds and prevelance of leaf scorch. Differences in plant growth are shown between the various chemical treatments, but in most instances the differences are not of great magnitude. Perhaps the greatest difference that does occur between chemical treatments and between steamed soil is the incidence of leaf scorch. In Table 1 of the 6 different chemical treatments Omadine 1565 shows the lowest amount of scorch injury, both in steamed and unsteamed soil. However, in Table 2, Omadine + Terrachlor treatment shows less scorch than any of the other 7 chemicals; but in Table 3, Oxyquinoline sulfate, an unrelated chemical, appears to be the best out of eleven treatments.

A study of the data on comparison of the amount of scorch with the same chemical treatments in steamed and unsteamed soil is of considerable interest. In Table 1, leaf scorch, in 3 chemical treatments out of 6, there was less scorch in steamed soil than in unsteamed. Whereas, in Table 2, 5 chemicals out of 7 show less scorch in steamed soil than in unsteamed. However, in Table 3, all eleven chemical treatments show less scorch in steamed than in unsteamed soil. Thus, it can be seen that of the several plant growth responses studied the occurrence of leaf scorch is the only one which shows any rather consistent differences in retation to any of the treatments.

Conclusions and Discussion

On the basis of data presented and under conditions which the experiments were conducted, one may conclude that a wide variety of chemicals and combinations may be used on Croft lily bulbs with considerable safety. Considering such plant growth responses as shoot emergence, number days to bloom, average plant height and number of flowers, variation does show between chemical treatments but to no great degree.

The differences in amount of leaf scorch between the chemical treatments in relation to steamed and unsteamed soil is quite evident from the data. Certainly it can be concluded that there is an interaction between chemical treatments and steamed soil. The fact that check plants with no chemical treatment show less scorch than in unsteamed soil indicates that steaming in some manner influences factors concerned with scorch symptoms. Further weight is added to the influence of steaming in that 19 of the 24 chemical treatments show less scorch in steamed soil; this represents approximately 79 percent of the total treatments.

Bald (1) suggests that where leaf scorch is concerned there may be other inciting agents involved other than soil organisms; also that if Rhizoctonia or some other factor incites scorch then an attempt to prevent leaf scorch by controlling nutrient levels is an attack on symptoms rather than on the causal agent. Hildebrandt, Beck, Reinert (2) testing a number of chemicals as dusts and dip treatments on Croft lily bulbs observed that in all treatments, except one, leaf scorch or tip burn was greater in steamed than unsteamed soil.

A number of workers (1,2,3,4) who have experimented with chemical treatments of lily bulbs state or imply that such treatments are desirable from a practical viewpoint.

The data presented in this experiment show that use of chemical dip treatments had no harmful effects on subsequent growth or flowering of lily bulbs. In regard to incidence of leaf scorch in Croft lilies, based on observations as to the relationship of steaming soil, the results shown would indicate that one should regard the problem of scorch as being one which involves a number of factors.

(1) Research Professor in Floriculture,
Department of Horticulture, Amherst, Mass.
(II) Research Professor in Plant Pathology,
Waltham Field Station, Waltham, Mass.

Literature Cited

1. Bald, J. F., A. M. Kofranek and O. R. Lunt. 1955. Leaf Scorch and Rhizonctonia on Croft Lilies. Phytopathology 45:156-162.

2. Hildebrandt, A. C., Gail E. Beck and R. Reinert. 1957. Bulb Treatments on Lilies. Florists' Review 121: 63-64, 127-129.

3. Willis, W. W. and W. J. Carpenter. 1957. Control of Root Rot of Croft Lilies. Kansas State College Florists' Bul. 41: 1-2

4. Willis, W. W. 1957. More About Chemical Treatments of Croft Lily Root Rot Kansas State College Florists' Bul. 46: 2-4

Table 2
The Effect of Different Chemical Treatments of Croft Lily Bulbs
(7-8 inch size) on Plant Growth
Amherst-Data

	Emergence average shoot growth in inches at 27 days		Number days to bloom-average		Plant height inches-average		Average number buds per plant		Number of scorch lesions per plant-average	
	Soil		Soil		Soil		Soil		Soil	
	steamed	not	steamed	not	steamed	not	steamed	not	steamed	not
Captan 50W	2.45	2.91	112	113	14.33	14.16	2.75	2.75	11.33	9.08
Terrachlor 75W	2.60	2.01	110	111	16.08	15.33	3.00	3.00	13.33	11.50
Captan+Terrachlor	2.90	2.41	113	114	15.50	14.41	3.16	3.25	4.83	11.41
Omadine 1562	2.70	3.25	109	110	15.08	14.58	2.75	2.83	8.25	12.91
OM+Terrachlor	2.71	2.00	114	113	14.66	14.58	2.83	3.08	2.66	3.83
Oxyquinoline sulfate	2.95	2.81	112	111	15.58	14.00	3.50	3.00	10.25	11.83
Oxyquinoline citrate	3.13	2.75	113	112	15.66	14.41	3.16	3.25	6.75	11.83
Total	19.44	18.14	783	784	106.89	101.41	21.15	21.16	57.40	72.39
Average	2.77	2.59	111.71	112.00	15.27	14.48	2.83	2.83	8.45	12.61
Checks	2.71	2.86	114	115	15.58	14.50	3.02	3.02	8.20	10.34

Table 3
The Effect of Different Chemical Treatments of Croft Lily Bulbs
(8-9 inch size) on Plant Growth
Waltham- Data

	Emergence average number of days from planting		Number days to bloom-average		Plant height in inches-average		Buds per plant average		Scorch lesions per plant-average	
	Soil		Soil		Soil		Soil		Soil	
	steamed	not	steamed	not	steamed	not	steamed	not	steamed	not
Captan 50W	25	24	101	101	13	14	4.88	5.11	4.55	16.44
Terrachlor 75W	24	24	98	102	13	14	5.11	5.33	13.00	22.88
Captan+Terrachlor	25	23	102	98	12	14	4.11	5.22	12.88	14.22
Omadine 1562	22	24	99	100	15	13	4.77	5.00	10.55	13.33
OM+Terrachlor	24	22	99	96	13	14	4.77	4.77	8.33	15.00
Spergon (Chlornil)	23	24	96	98	12	13	4.22	4.77	7.88	14.33
Spergon+Terrachlor	25	24	103	103	13	12	5.00	4.77	12.77	15.00
Crag 974	27	24	100	100	14	14	3.33	3.52	7.11	14.88
Oxyquinoline sulfate	25	24	98	98	10	10	2.66	2.88	3.55	8.77
FX ADO	28	23	99	97	10	10	2.77	3.22	2.66	13.44
Vancide Z-65	22	24	100	98	13	14	4.11	4.55	6.33	12.22
Total	270	260	1095	1091	138	142	45.73	49.14	89.81	160.51
Average	24.54	23.63	99.54	99.18	12.54	12.90	4.15	4.46	8.16	14.59
Roots removed	28	27	101	100	11	12	3.11	3.00	6.44	12.77
Checks	27	26	101	101	13	12	3.88	4.77	4.55	10.77