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# Seed and Soil Treatment *for the* Control of Damping-Off

By

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# SEED AND SOIL TREATMENT FOR THE CONTROL OF DAMPING-OFF

L. H. PERSON AND S. J. P. CHILTON

## INTRODUCTION

The disease commonly called damping-off affects many plants in the seedling stage. There are two phases of damping-off which are known as pre-emergence damping-off and post-emergence damping-off. In pre-emergence damping-off the seeds and young seedlings rot in the soil and never reach the surface. This may result in poor stands even when good seed are used. In the post-emergence damping-off the young plants become water-soaked at the soil line, collapse suddenly, and die. Most growers are usually more familiar with post-emergence damping-off and believe that it is caused by excessive moisture and periods of cool, cloudy weather. While these conditions are favorable for damping-off, the disease is caused by fungi that live in the soil or which are sometimes introduced with the seed. Isolations made over a period of three years from diseased seedlings indicate *Rhizoctonia* and *Pythium* to be the fungi mainly involved in Louisiana.

## Previous Work

Seed treatments for the control of certain seed-borne diseases have been recommended for some years, but only within the past 14 years has much work been done with seed of vegetable crops. In 1928 Clayton tested in the field and greenhouse a number of organic mercury compounds (Semesan, Uspulun) on vegetable seeds. Some of the treatments gave striking increases in stands in the greenhouse in midwinter, but in late spring there was little or no increase in stands from similar treatments. In 1930 Horsfall (3), in tests in greenhouses in New York, found that soaking tomato seed in copper sulfate solution gave remarkable increases in stand and the emerged seedlings were relatively free of disease. He also obtained increased stands by dusting seeds with cuprous oxide and other copper compounds. Later Horsfall (5) and co-workers studied the effect of the red copper oxide seed treatment on a large number of different plants. These treatments increased stands and gave very promising results on several vegetable crops. Horsfall (4) also found that zinc oxide when applied on the soil surface as a supplement to seed treatment gave satisfactory control of post-emergence damping-off of lettuce, peppers, spinach, and tomatoes. Wilson and Tilford (7) found formaldehyde dust to be a satisfactory substance for controlling damping-off on a number of vege-

table crops in Ohio. Cook and Callenbach (1) tested a number of compounds for the control of spinach damping-off in Virginia. They found that treatments with red copper oxide, zinc oxide, Semesan, and other materials increased stands in early fall plantings, but later plantings showed no benefit. Kadow and Anderson (6) made numerous tests with various seed and soil treatments under Illinois conditions.

## Objectives

A number of seed and soil treatments for the control of damping-off have come into commercial use during the last few years. As most of the results published on these treatments have come from Northern areas where conditions are different from those in the South, it seemed important to test, under Louisiana conditions, some of the more promising compounds which have been used for treating seeds and soil. This bulletin gives the results of tests with seed of certain vegetables and ornamental plants made during the last seven years.

These tests were conducted mostly in the University greenhouse at Baton Rouge. Soils of two types, Sharkey and Olivier, were used. The Sharkey is the common alluvial soil characteristic of the Mississippi River bottom. The Olivier is the upland or terrace soil occurring in East Baton Rouge Parish. Fresh soil was obtained for each test. This was screened and then thoroughly mixed to insure uniformity. Most of the tests were made in small flats, but a few were carried on in stationary benches in the greenhouse.

For these tests seeds were obtained from various commercial dealers. In the early tests, from 8 to 14 rows of 100 seeds each were planted in each flat. In later tests the number of seeds used for each treatment was reduced to 400 and the various treatments were replicated in 4 flats.

A number of different chemical compounds were tested in the treatments. These included red copper oxide (Cuprocide), yellow copper oxide, formaldehyde solution, various formaldehyde dusts, zinc oxide, Vasco 4, Spergon, and several of the organic mercury dusts.

The formaldehyde dusts were applied at the rate of  $1\frac{1}{2}$  ounces per square foot by mixing into the upper 3 inches of the soil. The flats were watered thoroughly immediately after planting.

The concentrated formaldehyde treatment was made by applying 30 cc. of formaldehyde (40% commercial formaldehyde) per square foot of soil. The formaldehyde was diluted to five or six times its volume with water, sprinkled over the soil, and mixed thoroughly into the upper four inches. The soil was allowed to stand from 24 to 36 hours after treatment.

The seed treatments, including those with the copper oxides, were made by shaking the seed in a closed container with an excess of the dust to be tested until well-covered. In all cases the excess dust was removed after treatment.

Zinc oxide and Vasco 4 when used to treat the soil surface were applied at the time the seedlings began to emerge by shaking on enough to cover the soil thoroughly. The quantity necessary to obtain good coverage was about 20 grams to the square foot of soil.

Yellow copper oxide was also used in suspension to treat the surface of the soil as the seedlings emerged. The concentration was  $1\frac{1}{4}$  ounce of the oxide to one gallon of water.

In all tests the flats were held under conditions as nearly alike as possible. The flats were kept somewhat more moist than under normal growing conditions in order to give the treatments as drastic a test as possible.

After the seedlings emerged from the soil the plants were removed and counted as they damped off. At the end of the test the remaining plants were counted. By this method both the number of plants that emerged from the ground and the actual number of plants which remained at the end of the tests were determined. Final counts were made when damping-off had stopped.

### **Experimental Results**

The results which were obtained in the various seed and soil treatment tests conducted over a period of years are presented in the following pages. In most cases these are presented in tables so arranged as to give a comparison of the efficiency of the more important compounds which are in general use or have been recommended for treating seed and soil.

In table 1 are included the results obtained in tests in which red copper oxide and two commercial formaldehyde dusts were compared. The copper oxide was used to treat the seed and the formaldehyde dusts were used to treat the soil. Seeds of bell pepper, eggplant, and tomato were used in the tests.

All the treatments about doubled the emergence and stand of tomatoes. The red copper oxide seed treatment was slightly superior to the formaldehyde dusts. The increases in emergence and stand were not as striking with bell peppers as with tomatoes, the untreated seed giving an average stand of 48.9 per cent and the treatments from 58.6 per cent to 61.3 per cent. The red copper oxide seed treatment also resulted in the best stands with bell peppers. With eggplants considerably better results were obtained with the red copper oxide than with the formaldehyde dusts. It nearly doubled both emergence and stand but post-emergence damping-off was heavy, as 55.9 per cent of the seed produced plants which emerged from the soil while only 31.6 per cent remained at the end of the tests. It is interesting to note that even though damping-off was more severe in the Olivier soil than in the Sharkey soil, the seed and soil treatments gave about the same number of plants emerging from both soils.



TABLE 1. RESULTS OF TESTS COMPARING RED COPPER OXIDE AND TWO FORMALDEHYDE DUSTS. THE COPPER OXIDE WAS USED TO TREAT THE SEED AND THE FORMALDEHYDE DUSTS TO TREAT THE SOIL.

Soil type	Number of tests	Total number of seed	PER CENT EMERGENCE				PER CENT STAND			
			Check	Red copper oxide	FORMALDEHYDE DUST		Check	Red copper oxide	FORMALDEHYDE DUST	
					No. 1*	No. 2*			No. 1*	No. 2*
TOMATOES										
Sharkey.....	8	7,000	40.1	69.0	68.8	65.6	37.6	65.0	64.7	62.3
Olivier.....	8	7,000	29.2	75.8	63.7	69.0	26.8	72.4	62.7	67.6
Average.....		14,000	34.7	72.4	66.8	67.3	32.2	68.7	63.7	65.0
BELL PEPPERS										
Sharkey.....	7	6,100	53.0	64.3	64.5	60.1	48.3	60.4	60.9	55.6
Olivier.....	7	6,100	54.7	65.0	60.8	67.8	49.5	62.1	56.3	63.3
Average.....		12,200	53.9	64.7	62.7	64.0	48.9	61.3	58.6	59.5
EGGPLANTS										
Sharkey.....	8	7,000	30.9	53.3	35.6	31.7	17.6	30.2	19.3	18.4
Olivier.....	8	7,000	32.4	58.5	37.8	45.9	19.3	33.0	27.8	24.2
Average.....		14,000	31.6	55.9	36.7	38.8	18.5	31.6	23.6	21.3

\*Formaldehyde dust No. 1 was obtained from the Grasselli Chemical Co., and No. 2 from the Ansul Chemical Co.

In table 2 are included results of tests in which Formacide was compared with red copper oxide. The Formacide was used to treat the soil and the copper oxide to treat the seed. With tomatoes and bell peppers Formacide gave about the same increases in stands as did the red copper oxide. With eggplants it was less efficient.

TABLE 2. RESULTS OF TESTS COMPARING RED COPPER OXIDE AND FORMACIDE. THE COPPER OXIDE WAS USED TO TREAT THE SEED AND THE FORMACIDE TO TREAT THE SOIL.

Soil type	No. of tests	Total number seed	PER CENT EMERGENCE			PER CENT STAND		
			Check	Red copper oxide	Formacide*	Check	Red copper oxide	Formacide*
TOMATOES								
Sharkey.....	9	8,000	52.6	80.8	78.0	46.7	74.0	70.0
Olivier.....	9	8,000	35.4	80.8	72.5	32.6	77.4	71.8
Average...		16,000	44.0	80.8	75.3	39.7	75.7	70.9
BELL PEPPERS								
Sharkey.....	9	8,000	61.0	74.1	74.1	56.0	70.3	68.5
Olivier.....	9	8,000	59.7	70.3	73.3	53.0	67.8	70.3
Average...		16,000	60.4	72.2	73.7	54.5	69.0	69.4
EGGPLANTS								
Sharkey.....	8	7,100	39.4	61.7	47.0	22.2	39.2	24.0
Olivier.....	8	7,100	41.9	65.8	47.0	21.4	43.5	38.0
Average...		14,200	40.7	63.8	47.0	21.8	41.4	31.0

\*Formacide was obtained from the Hammond Paint and Chemical Co.

In table 3 are included results of tests in which formaldehyde (40% solution) was compared with red copper oxide. The formaldehyde was used to sterilize the soil before the seed were planted, while the copper oxide was used to treat the seed. The results show that with tomatoes the formaldehyde was slightly more efficient than red copper oxide. Emergence and stand were about the same with peppers. In the Sharkey soil the formaldehyde soil treatment was much superior to the red copper oxide seed treatment in preventing post-emergence damping-off. In one test made in the Olivier soil it seemed to be toxic to eggplant seed, causing a reduction in germination.



TABLE 3. RESULTS OF TESTS COMPARING RED COPPER OXIDE AND FORMALDEHYDE SOLUTION (40%). THE COPPER OXIDE WAS USED TO TREAT THE SEED AND THE FORMALDEHYDE TO TREAT THE SOIL.

Soil type	No. of tests	Total number seed	PER CENT EMERGENCE			PER CENT STAND		
			Check	Red copper oxide	Formaldehyde	Check	Red copper oxide	Formaldehyde
TOMATOES								
Sharkey.....	4	4,200	50.0	83.5	88.1	43.2	74.8	85.6
Olivier.....	4	4,200	27.1	75.8	72.9	24.6	71.0	72.8
Average...		8,400	38.6	79.7	80.5	33.9	72.9	79.2
BELL PEPPERS								
Sharkey.....	4	4,200	66.5	83.2	83.7	60.5	79.1	81.1
Olivier.....	4	4,200	55.2	76.0	70.3	50.1	74.1	66.9
Average...		8,400	60.9	79.6	77.0	55.3	76.6	74.0
EGGPLANTS								
Sharkey.....	3	3,300	60.7	73.4	73.4	26.3	43.4	66.6
Olivier.....	1	900	32.6	74.3	28.7	9.2	24.9	28.7
Average...		4,200	46.7	73.9	51.0	17.8	34.2	47.7

In table 4 are included results of tests in which Ceresan was compared with red copper oxide. Both were used to treat the seed. Increases of stands of tomatoes were about the same with Ceresan as with the copper oxide. Ceresan, however, was definitely toxic to both bell peppers and eggplants in the Olivier soil, the germination being lowered.

In table 5 are included results of tests in which red copper oxide obtained from the Merck Chemical Company was compared with Metrox, or commercial red copper oxide obtained from the Metals Refining Co. These products were about equally efficient.

In table 6 are included results of tests to determine the value of zinc oxide as a soil dressing. The seeds were treated with red copper oxide before planting and the zinc oxide was applied to the soil at the time of emergence of the seedlings. The zinc oxide was of little value with tomatoes and bell peppers, but decreased considerably the post-emergence damping-off of eggplants.

TABLE 4. RESULTS OF TESTS COMPARING RED COPPER OXIDE AND CERESAN. BOTH USED TO TREAT THE SEED.

Soil type	No. of tests	Total number seed	PER CENT EMERGENCE			PER CENT STAND		
			Check	Red copper oxide	Ceresan	Check	Red copper oxide	Ceresan
TOMATOES								
Sharkey.....	5	4,300	50.2	77.3	81.5	44.0	66.5	63.4
Olivier.....	5	4,300	31.9	78.5	80.7	28.1	73.0	70.4
Average...		8,600	41.0	77.9	81.1	36.1	69.8	66.7
BELL PEPPERS								
Sharkey.....	5	4,300	59.3	73.6	76.0	52.0	67.6	64.2
Olivier.....	5	4,300	62.0	75.4	40.6	54.4	71.4	38.1
Average...		8,600	60.7	74.5	58.3	53.2	69.5	51.2
EGGPLANTS								
Sharkey.....	4	3,400	35.1	57.8	53.4	20.1	30.0	27.7
Olivier.....	4	3,400	41.8	64.1	28.9	20.6	31.0	18.1
Average...		6,800	38.5	61.0	41.2	20.4	30.5	22.9

In table 7 are included results of tests with eggplants and cabbages in which various combinations of red and yellow copper oxide, Vasco 4, and zinc oxide were used to treat the seed and soil. Yellow copper oxide and Vasco 4 applied to the soil surface gave about the same increases in stands of eggplants by controlling post-emergence damping-off. With cabbages Vasco 4 and zinc oxide on the seed and soil were about equally efficient in increasing stands and were superior to the combination of red copper oxide on the seed and yellow copper oxide on the soil.

In table 8 are included results of tests with seeds of various ornamental plants. Red copper oxide, yellow copper oxide, Vasco 4, zinc oxide, and Dubay 1286a were used to treat the seed. The yellow copper oxide gave the best results with Calendula, Zinnia, Centaurea, Pansy, and Cosmos. Zinc oxide gave the best results with Salvia. In general, red copper oxide gave better results than Vasco 4, which in turn was superior to zinc oxide. Dubay 1286a did not seem to be as efficient as the copper oxides.

TABLE 5. RESULTS OF TESTS COMPARING MERCK'S RED COPPER OXIDE AND METROX. BOTH USED TO TREAT THE SEED.

Soil type	No. of tests	Total number seed	PER CENT EMERGENCE			PER CENT STAND		
			Check	Merck's red copper oxide*	Metrox	Check	Merck's red copper oxide	Metrox
TOMATOES								
Sharkey.....	3	2,500	59.1	69.0	62.6	56.2	64.8	59.8
Olivier.....	3	2,500	26.1	75.0	70.4	23.5	71.9	66.3
Average...		5,000	42.6	72.0	66.5	39.9	68.4	63.0
BELL PEPPERS								
Sharkey.....	3	2,500	59.3	61.4	65.0	56.2	56.9	63.8
Olivier.....	3	2,500	52.7	73.4	71.6	43.7	66.6	71.2
Average...		5,000	56.0	67.4	68.3	50.0	61.8	67.5
EGGPLANTS								
Sharkey.....	3	2,500	30.7	48.8	48.1	22.0	34.3	35.6
Olivier.....	3	2,500	34.4	53.8	51.8	20.5	32.7	31.0
Average...		5,000	32.6	51.3	50.0	21.3	33.5	33.3

\*Merck's red copper oxide obtained from the Merck Chemical Co. and Metrox from Metals Refining Co., Hammond, Indiana.

In table 9 are included results of tests in which Sperguson was compared with yellow copper oxide. In general, Sperguson did not give as satisfactory results as did the yellow copper oxide. The emergence was in most cases satisfactory but the final stands were lower.

In table 10 are included results of seed treatment tests with ornamental plants in which yellow copper oxide was compared with some of the organic mercury compounds, Ceresan, New Improved Ceresan, and New Improved Semesan, Jr., New Improved Ceresan was too toxic to be used at full strength. The New Improved Semesan, Jr., and the 2% Ceresan were also toxic in some cases.

TABLE 6. RESULTS OF TESTS WITH RED COPPER OXIDE AND ZINC OXIDE. THE COPPER OXIDE WAS USED TO TREAT THE SEED AND THE ZINC OXIDE AS A SOIL DRESSING.

Soil type	No. of tests	Total number seed	PER CENT EMERGENCE			PER CENT STAND		
			Check	Red copper oxide	Red copper oxide and zinc oxide	Check	Red copper oxide	Red copper oxide and zinc oxide
TOMATOES								
Sharkey.....	6	5,500	43.5	81.1	77.7	36.6	73.8	76.9
Olivier.....	6	5,500	37.6	79.6	76.3	35.7	77.1	75.5
Average...		11,000	40.6	80.4	77.0	36.2	75.5	76.2
BELL PEPPERS								
Sharkey.....	6	5,500	60.1	74.9	76.2	52.7	70.9	75.8
Olivier.....	6	5,500	58.8	66.9	69.0	53.4	65.8	68.8
Average...		11,000	59.5	70.9	72.6	53.0	68.4	72.3
EGGPLANTS								
Sharkey.....	5	4,600	44.9	67.4	69.9	21.3	41.3	60.8
Olivier.....	5	4,600	42.4	68.6	66.5	20.3	53.9	62.4
Average...		9,200	43.7	68.0	68.2	20.8	47.6	61.6

TABLE 7. RESULTS OF TESTS WITH RED AND YELLOW COPPER OXIDES, VASCO 4, AND ZINC OXIDE (PER CENT STAND).

	Number of seed	Check	Red copper oxide on seed, yellow copper oxide on soil	Red Copper oxide on seed, Vasco 4 on soil	Vasco 4 on seed and on soil	Zinc oxide on seed and on soil
EGGPLANT						
	1,800	50.0	72.8	69.6	....	....
	2,400	39.3	73.3	73.8	....	....
Average.....	4,200	44.7	73.1	71.7	....	....
CABBAGE						
	1,200	17.3	34.9	....	64.9	71.0
	300	67.7	79.7	80.7	88.0	87.0
Average.....	1,500	42.5	57.3	....	76.5	79.0

TABLE 8. RESULTS OF SEED TREATMENT WITH VARIOUS ORNAMENTAL PLANTS

Plant	Number of tests	Total Number seed	Check	Red copper oxide	Yellow copper oxide	Vasco 4	Zinc oxide	Dubay 1286a
PER CENT EMERGENCE								
Calendula.....	5	2,000	20.8	51.6	57.6	53.0	49.4	49.3
Zinnia.....	3	1,000	23.4	55.1	60.6	43.9	32.7	62.0
Salvia.....	3	1,100	10.6	17.8	15.8	18.0	20.6	....
Centaurea.....	2	800	3.0	53.4	58.8	10.2	7.5	37.4
Pansy.....	2	800	6.6	16.8	30.0	12.8	....	....
Cosmos.....	2	700	35.7	55.4	59.1	48.1	44.0	49.1
Snapdragons.....	4	1,600	25.3	....	25.1	....	24.5	14.4
PER CENT STAND								
Calendula.....	5	2,000	16.1	34.1	45.7	40.0	32.8	34.6
Zinnia.....	3	1,000	17.6	52.9	61.0	35.8	25.9	56.6
Salvia.....	3	1,100	9.1	15.5	15.4	15.4	20.2	....
Centaurea.....	2	800	0.1	45.6	51.9	6.6	5.1	5.0
Pansy.....	2	800	4.9	11.9	19.9	11.5	....	....
Cosmos.....	2	700	32.9	52.4	57.1	44.1	37.6	44.4
Snapdragon.....	4	1,600	24.3	....	22.3	....	22.6	14.2

TABLE 9. RESULTS OF SEED TREATMENT TESTS WITH SEED OF ORNAMENTAL PLANTS COMPARING SPERGON WITH YELLOW COPPER OXIDE.

Plant	Number of tests	Total number of seed	Check	Yellow copper oxide	Spergon
EMERGENCE					
Calendula.....	3	1,200	16.3	60.8	51.5
Zinnia.....	2	600	25.5	64.7	65.2
Salvia.....	3	1,100	10.6	15.8	18.0
Centaurea.....	2	800	3.0	58.8	21.9
Pansy.....	1	400	3.5	33.5	7.8
Cosmos.....	2	700	35.7	59.1	53.1
STAND					
Calendula.....	3	1,200	11.2	42.2	27.5
Zinnia.....	2	600	17.3	60.2	52.7
Salvia.....	3	1,100	9.1	15.5	15.3
Centaurea.....	2	800	2.0	51.9	29.0
Pansy.....	1	400	1.8	15.0	4.3
Cosmos.....	2	700	32.9	57.1	47.0



TABLE 10. RESULTS OF SEED TREATMENT TESTS WITH SEED OF ORNAMENTAL PLANTS COMPARING SOME OF THE ORGANIC MERCURY COMPOUNDS WITH YELLOW COPPER OXIDE.

Plant	Number of seed	Check	Yellow copper oxide	New Improved Ceresan	New Improved Semesan Jr.	Ceresan
EMERGENCE						
Pansy.....	400	9.8	26.5	....	9.0	15.3
Calendula.....	400	29.3	56.5	0.5	13.5	6.3
Zinnia.....	400	18.0	62.3	0.3	50.8	41.0
Nasturtium.....	400	56.5	62.3	0.0	53.0	56.3
Snapdragon.....	400	28.3	35.0	16.3	41.5	42.5
Snapdragon.....	400	50.8	36.8	1.3	34.3	5.5
STAND						
Pansy.....	400	8.0	24.8	....	9.0	14.5
Calendula.....	400	26.5	53.5	0.5	12.8	4.8
Zinnia.....	400	18.0	62.3	0.3	50.8	41.0
Nasturtium.....	400	56.5	62.3	0.0	53.0	56.3
Snapdragon.....	400	28.3	35.0	16.3	41.5	42.5
Snapdragon.....	400	50.8	36.8	1.2	34.3	5.5

## SUMMARY

Results of studies over a period of seven years on the control of damping-off under Louisiana conditions by the use of seed and soil treatments are presented. Sharkey and Olivier soils were used in the tests.

Red copper oxide when used to treat the seed was found to be the most practical and effective material to control damping-off of tomatoes and bell peppers. Red copper oxide on the seed was not sufficient to control post-emergence damping-off of eggplants. Vasco 4 and zinc oxide gave the best results with cabbages. Red copper oxide was toxic to cabbages.

The commercial formaldehyde dusts when used to treat the soil were about as efficient as red copper oxide on the seed with tomatoes and bell peppers but were of little value with eggplants.

Zinc oxide, Vasco 4, and yellow copper oxide when used to treat the soil surface were about equally effective in controlling post-emergence damping-off of eggplants.

Concentrated formaldehyde solution (40% formaldehyde) diluted in 5 or 6 times its volume of water was effective in controlling damping-off of tomatoes, peppers, and eggplants, but was toxic to eggplants in the Olivier soil.

With seed of ornamental plants, yellow copper oxide was the most efficient, followed by red copper oxide, Vasco 4, and zinc oxide in the order named. The organic mercury dusts were often toxic when applied full strength.

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## RECOMMENDATIONS

The following recommendations have been found by the Louisiana Agricultural Experiment Station to be satisfactory in controlling damping-off.

**Cabbage:** Treat the seed with Vasco 4 or zinc oxide (Treatment 2). If plants begin to damp-off after coming up apply Vasco 4 or zinc oxide on the soil (Treatment 4). Do not use red or yellow copper oxide on cabbage seed as these compounds are often toxic.

**Eggplants:** Treat the seed with red copper oxide or yellow copper oxide (Treatment 1). When the plants begin to break through the soil *always* water the plants with a suspension of red or yellow copper oxide in water (Treatment 3) or apply either Vasco 4 or zinc oxide as a soil cover (Treatment 4).

**Peppers:** Treat the seed with red copper oxide or yellow copper oxide (Treatment 1). Usually seed treatment is enough, but if the plants damp-off after coming up, either water the soil with a red or yellow copper oxide suspension in water (Treatment 3) or apply Vasco 4 or zinc oxide to the soil (Treatment 4).

**Tomatoes:** Treat the seed with red copper oxide or yellow copper oxide (Treatment 1). The seed treatment is usually enough but if plants damp-off after coming up, water the soil with a red or yellow copper oxide suspension in water (Treatment 3) or apply Vasco 4 or zinc oxide to the soil (Treatment 4).

Ornamental Plants: Treat the seed with red copper oxide or yellow copper oxide (Treatment 1). Results indicate the yellow copper oxide to be somewhat better. This treatment has given satisfactory results with the following:

Calendula	Cosmos	Salvia
Centaurea	Pansy	Zinnia

Results at other experiment stations in the United States indicate that seed treatment is of value with many other plants than those given above. The plants and the treatments recommended are given below:

Red Copper Oxide (Treatment 1).

Vegetables:

Beets	Pea
Carrots	Pumpkin
Cucumbers	Romaine
Endive	Spinach
Escarole	Squash
Lettuce	Swiss chard
Muskmelon	Watermelon

Ornamentals:

Anchusa	Eschscholtzia	Marigold (French)
Arabas	Gypsophila	Mesembryanthum
Arbor vitae	Helichrysum	Nasturtium
China aster	Heliopsis	Penstemon
Cobaeae	Hollyhock	Phlox drummondii
Cockscomb	Leptosiphon	Pyrethrum
Dahlia	Lupine	Salpiglossis
Digitalis	Marigold (African)	Sweet Pea
		Venidium

Vasco 4 or Zinc Oxide (Treatment 2).

Cauliflower	Radish
Kale	Turnip
Kohlrabi	

## TREATMENTS RECOMMENDED

### Treatment 1

*Seed treatment with red copper oxide or yellow copper oxide.* Either of these compounds should be applied to the seed at the rate of  $1\frac{1}{2}$  level teaspoonful per pound of small seed and  $\frac{1}{2}$  teaspoonful per pound of large seed. To treat, place the dust and seed in a tight container and shake until all the seed are well-covered. For small quantities of seed, use only enough dust to coat each seed. If too much dust is present the seed should be screened to remove the excess. If the treated seed are to be used

in a drill,  $\frac{1}{2}$  as much graphite by weight as copper oxide should be added at the time the seed are treated. This prevents the seed clogging the drill.

Red copper oxide is frequently sold under the trade name of *Cuproside*. Frequently the name *Yellow Cuproside* is used for the yellow copper oxide.

### **Treatment 2**

*Seed treatment with Vasco 4 or zinc oxide.* Either of these compounds should be applied to the seed at the rate of two level teaspoonfuls to the pound of seed. To treat, place the dust and seed in a tight container and shake until all the seed are well-covered. If the seed are to be used in a drill add  $\frac{1}{2}$  as much graphite as dust when the seed are treated. The seed should be screened after the treatment to remove any excess dust.

Apparently, due to war priorities, Vasco 4 is no longer manufactured. At present, however, there may be some still in the hands of dealers.

### **Treatment 3**

*Soil treatment with red copper oxide or yellow copper oxide.* Add  $1\frac{1}{4}$  oz. (6 level teaspoonfuls) of either copper oxide to one gallon of water and stir thoroughly. This should be sprinkled on the surface of the soil when the young plants are emerging. This treatment may be repeated if the plants begin to damp-off.

### **Treatment 4**

*Soil treatment with Vasco 4 or zinc oxide.* Either of these substances should be applied to the soil at the time the young plants are emerging. Enough should be applied to thoroughly cover the soil surface. Either can be applied by punching holes through the bottom of a can and shaking the dust through the holes. Two ounces of the dust will usually be enough to cover about 3 square feet of soil surface. Care should be taken not to break the layer of the chemical on the surface of the soil.

Zinc oxide can be obtained under such trade names as Zinc White, Paint White, or Leafox 200.