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THESIS.
INSECTICIDES AND FUNGICIDES.

J. E. W. Tracy. 1896.

*Indoctrination
Fungicide*

T H E S I S

on

INSECTICIDES AND FUNGICIDES

by

J. E. Woodbridge Tracy.

THESIS

INSECTICIDES AND FUNGICIDES.

During the last nine or ten years an increased interest has been manifested in the practice of spraying as a means of holding in check certain insect pests and diseases of plants, especially those due to fungi. In this work wonderful improvements have been made especially in this country where it has been stimulated by the general and state government, and the agricultural and horticultural press.

The beneficial effects of spraying, so far as a prevention of injury from fungi and the attacks from insects are concerned, are now so well recognized that little indeed need be said on the subject. Many of the most destructive diseases of our crops may be readily controlled at a comparatively small expense by the proper application of certain fungicides.

Besides preventing the injury done by fungi and insects there is still another phase of the spraying question which, although as yet has received very little attention, is of great importance. This is the effect of certain fungicides on the growth of plants independent of other considerations. Almost from the beginning of the work in this country it was observed that when certain preparations were used as fungicides the plants made a better growth, yielded a better harvest, and in some cases gave an earlier product than those untreated even though they had no disease present or any insects upon them.

The effect of spraying in this direction has been especially marked in the case of the potato, and also where nursery stock has been under treatment. The yield of potatoes has been frequently increased from 25 to 50 % quite independent of any effects produced on the plants by holding in check fungous diseases and pest. We thus see the great importance of spraying.

While a number of preparations and solutions used as fungicides have given promise of value none have been found which filled so many requirements as the Bordeaux Mixture, and it is probably more generally used today than all other fungicides combined. The chief points in its favor are:

1. Its thorough effectiveness as a fungicide.
2. Its cheapness.
3. Its safety from a hygienic standpoint.
4. Its harmlessness to the sprayed plants.
5. Its beneficial effect on plants other than those resulting from the mere prevention of the attacks of parasites.

The use of Bordeaux Mixture originated in France in the neighborhood of the city of Mende, which is situated on the banks of the river Gironde. It was first used as a paste and sprinkled on vines and trellises near highways to keep boys from pillaging the vineyards. Prof. A. Millardet professor of botany in the Academy of Sciences at Bordeaux France, in a visit to this region in 1882 found that the vines where this solution had been applied did not suffer from mildew. He carried on experiments to test its value with fairly good

results, until in 1884 he published an account of what he had done. From that time it has rapidly come into general use.

All things considered we believe that the best results will be obtained from the use of a mixture made by the following formula:

Copper Sulphate (Cu S O_4)	4 pounds.
Fresh unslaked lime ($\text{Ca O.H}_2\text{O}$)	4 "
Water	40 gallons.

This can be most easily mixed by placing six gallons of water in a tub or barrel and in this hang four pounds of copper sulphate in a burlap or other coarse sack. Slake the lime, being careful not to add the water faster than the lime will take it up. Strain the lime to remove any lumps that may not have slaked. Pour together and dilute to forty gallons. Enough lime should be added to neutralize the free acid for if this is not done it will injure the foliage. A good way to test this is to add a few drops of ferro-cyanide of potassium to the solution before it is diluted and if it turns brown the lime is deficient and more should be added until the ferro-cyanide shows no change in color.

Certain chemical combinations take place from the mixing of the copper sulphate and the lime solution. The copper is precipitated as cupric hydroxide forming at the same time a slightly soluble sulphate of lime. These two salts together with an excess of lime remain in suspension in the Bordeaux Mixture. The reactions are simple and are expressed

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by the formula $\text{CuSO}_4 \cdot 5\text{H}_2\text{O} + \text{CaO} \cdot \text{H}_2\text{O} + \text{Cu}(\text{OH})_2 + \text{CaSO}_4 + 5\text{H}_2\text{O}$. From this formula a simple calculation shows that to precipitate four pounds of copper sulphate there would be required but .89 pounds of lime. However as the lime is usually very impure it has been found by careful experiments that we need a much greater amount than this and that equal parts of lime and copper sulphate give the best results.

It will be noticed that this preparation although not as complex and not as difficult to prepare as many, takes considerable time and more or less experience which probably has much to do with its not being used more generally by market gardeners and those who have but a small number of plants that would be benefited by its use. To overcome this somewhat serious objection it was thought best to experiment with one or more solutions which could be easily and rapidly prepared with comparatively little care.

As Bordeaux Mixture contains as much if not more copper sulphate than lime and it has shown such remarkable results it was thought best to experiment with crystals of copper sulphate dissolved in water. The experiments with this were carried on along several lines. First. A number of different kinds of ordinary flowering plants were sprayed with three different strengths of a solution in which the copper sulphate had been dissolved for the purpose of ascertaining at what strength it could be safely used upon the plants.

Second. A similar experiment was tried with soft water being used instead of hard water to see if there was enough lime in the hard water to make an appreciable difference in

the two, it being remembered that copper sulphate added to lime makes Bordeaux Mixture.

Third. Zenoleum, a waste oil product, was used on similar plants to find how strong it could be used without doing injury to the plants.

Fourth. Both Zenoleum and the soft water solution of copper sulphate were used on a large number of trees and shrubs also on five fruit trees, to see if the strength not injurious to the flowering plants were injurious to these.

Fifth. Different vegetables and berries were sprayed with the soft water solution of copper sulphate of a strength one part of copper sulphate to one thousand parts of water, and a Zenoleum solution of one part of Zenoleum to sixty parts of water.

Sixth. The soft water solution of copper sulphate and Bordeaux Mixture were used side by side on raspberries, strawberries, pears, apples, and carnations to see their relative merits as fungicides.

Seventh. Zenoleum was used on a number of plants having scale, red spider, thrip, aphids, and fungi on them to see if these were killed.

Following are the tables of the experiments and the results reached from them.

Experiment I.

This experiment consisted in spraying 12 varieties of the following plants with three different strengths of a hard water solution of copper sulphate. The plants were divided into four lots, each lot having the same number of

1. The first step in the process of the scientific method is to make an observation or ask a question.

2. The second step is to do background research to learn what is already known about the topic.

3. The third step is to form a hypothesis, which is a prediction or an educated guess about the outcome of the experiment.

4. The fourth step is to design and conduct an experiment to test the hypothesis.

5. The fifth step is to analyze the data and draw a conclusion based on the results of the experiment.

6. The sixth step is to communicate the results of the experiment to others.

7. The seventh step is to repeat the experiment to verify the results.

8. The eighth step is to use the results of the experiment to make a prediction about the future.

9. The ninth step is to use the results of the experiment to make a conclusion about the hypothesis.

10. The tenth step is to use the results of the experiment to make a prediction about the future.

11. The eleventh step is to use the results of the experiment to make a conclusion about the hypothesis.

12. The twelfth step is to use the results of the experiment to make a prediction about the future.

13. The thirteenth step is to use the results of the experiment to make a conclusion about the hypothesis.

14. The fourteenth step is to use the results of the experiment to make a prediction about the future.

15. The fifteenth step is to use the results of the experiment to make a conclusion about the hypothesis.

16. The sixteenth step is to use the results of the experiment to make a prediction about the future.

17. The seventeenth step is to use the results of the experiment to make a conclusion about the hypothesis.

18. The eighteenth step is to use the results of the experiment to make a prediction about the future.

19. The nineteenth step is to use the results of the experiment to make a conclusion about the hypothesis.

20. The twentieth step is to use the results of the experiment to make a prediction about the future.

21. The twenty-first step is to use the results of the experiment to make a conclusion about the hypothesis.

22. The twenty-second step is to use the results of the experiment to make a prediction about the future.

23. The twenty-third step is to use the results of the experiment to make a conclusion about the hypothesis.

24. The twenty-fourth step is to use the results of the experiment to make a prediction about the future.

25. The twenty-fifth step is to use the results of the experiment to make a conclusion about the hypothesis.

26. The twenty-sixth step is to use the results of the experiment to make a prediction about the future.

27. The twenty-seventh step is to use the results of the experiment to make a conclusion about the hypothesis.

28. The twenty-eighth step is to use the results of the experiment to make a prediction about the future.

plants and of the same variety. Lot 1 was sprayed with a solution 1-250. Lot 2 was sprayed with a solution 1-500. Lot 3 was sprayed with a solution 1-1000. Lot 4 was not sprayed at all but was simply used as check upon the work of the other three lots. All plants were sprayed five times at intervals of one week. Notes were taken the second day after each spraying.

Table 1.

Geranium Sprayed on April 6	Lot I.	Lot II.	Lot III.	Lot IV.
	O.K.	O.K.	O.K.	O.K.
" 13	"	"	"	"
" 20	"	"	"	"
" 28	"	"	"	"
May 4	"	"	"	"
Stock. April 6	Greenhouse smoked which made all plants			
" 13	sickly until by April 20th they were			
" 20	disregarded on account of being prac-			
" 28	tically dead.			
May 4.				
Begonia. Sprayed on April 6	Greenhouse smoked which wilted plants considerable.			
" 13	Plants in same condition today as on April 6th.			
" 20	Same	Same	Looks better.	Looks better.
" 28	Not as well as on Apr.20.	"	" much "	" much "
May 4	Still worse today.	"	Practically recovered.	Practically recovered.

1. The first part of the report is a general introduction to the project. It describes the purpose of the study, the objectives, and the scope of the work. It also provides a brief overview of the methodology used in the research.

2. The second part of the report is a detailed description of the data collection process. It explains how the data was gathered, the sources of the information, and the methods used to ensure its accuracy and reliability.

3. The third part of the report presents the results of the study. It includes a summary of the findings, a discussion of the implications of the results, and a comparison of the findings with previous research in the field.

4. The fourth part of the report is a conclusion and a list of references. The conclusion summarizes the main points of the study and provides recommendations for future research. The references list the sources of information used in the study.

Appendix A

Item No.	Item Description	Item Code	Item Price	Item Quantity	Item Total
1.	Item 1	101	10.00	1	10.00
2.	Item 2	102	20.00	2	40.00
3.	Item 3	103	30.00	3	90.00
4.	Item 4	104	40.00	4	160.00
5.	Item 5	105	50.00	5	250.00
6.	Item 6	106	60.00	6	360.00
7.	Item 7	107	70.00	7	490.00
8.	Item 8	108	80.00	8	640.00
9.	Item 9	109	90.00	9	810.00
10.	Item 10	110	100.00	10	1000.00
11.	Item 11	111	110.00	11	1210.00
12.	Item 12	112	120.00	12	1440.00
13.	Item 13	113	130.00	13	1690.00
14.	Item 14	114	140.00	14	1960.00
15.	Item 15	115	150.00	15	2250.00
16.	Item 16	116	160.00	16	2560.00
17.	Item 17	117	170.00	17	2890.00
18.	Item 18	118	180.00	18	3240.00
19.	Item 19	119	190.00	19	3610.00
20.	Item 20	120	200.00	20	4000.00
21.	Item 21	121	210.00	21	4410.00
22.	Item 22	122	220.00	22	4840.00
23.	Item 23	123	230.00	23	5290.00
24.	Item 24	124	240.00	24	5760.00
25.	Item 25	125	250.00	25	6250.00
26.	Item 26	126	260.00	26	6760.00
27.	Item 27	127	270.00	27	7290.00
28.	Item 28	128	280.00	28	7840.00
29.	Item 29	129	290.00	29	8410.00
30.	Item 30	130	300.00	30	9000.00
31.	Item 31	131	310.00	31	9610.00
32.	Item 32	132	320.00	32	10240.00
33.	Item 33	133	330.00	33	10890.00
34.	Item 34	134	340.00	34	11560.00
35.	Item 35	135	350.00	35	12250.00
36.	Item 36	136	360.00	36	12960.00
37.	Item 37	137	370.00	37	13690.00
38.	Item 38	138	380.00	38	14440.00
39.	Item 39	139	390.00	39	15210.00
40.	Item 40	140	400.00	40	16000.00
41.	Item 41	141	410.00	41	16810.00
42.	Item 42	142	420.00	42	17640.00
43.	Item 43	143	430.00	43	18490.00
44.	Item 44	144	440.00	44	19360.00
45.	Item 45	145	450.00	45	20250.00
46.	Item 46	146	460.00	46	21160.00
47.	Item 47	147	470.00	47	22090.00
48.	Item 48	148	480.00	48	23040.00
49.	Item 49	149	490.00	49	24010.00
50.	Item 50	150	500.00	50	25000.00
51.	Item 51	151	510.00	51	26010.00
52.	Item 52	152	520.00	52	27040.00
53.	Item 53	153	530.00	53	28090.00
54.	Item 54	154	540.00	54	29160.00
55.	Item 55	155	550.00	55	30250.00
56.	Item 56	156	560.00	56	31360.00
57.	Item 57	157	570.00	57	32490.00
58.	Item 58	158	580.00	58	33640.00
59.	Item 59	159	590.00	59	34810.00
60.	Item 60	160	600.00	60	36000.00
61.	Item 61	161	610.00	61	37210.00
62.	Item 62	162	620.00	62	38440.00
63.	Item 63	163	630.00	63	39690.00
64.	Item 64	164	640.00	64	40960.00
65.	Item 65	165	650.00	65	42250.00
66.	Item 66	166	660.00	66	43560.00
67.	Item 67	167	670.00	67	44890.00
68.	Item 68	168	680.00	68	46240.00
69.	Item 69	169	690.00	69	47610.00
70.	Item 70	170	700.00	70	49000.00
71.	Item 71	171	710.00	71	50410.00
72.	Item 72	172	720.00	72	51840.00
73.	Item 73	173	730.00	73	53290.00
74.	Item 74	174	740.00	74	54760.00
75.	Item 75	175	750.00	75	56250.00
76.	Item 76	176	760.00	76	57760.00
77.	Item 77	177	770.00	77	59290.00
78.	Item 78	178	780.00	78	60840.00
79.	Item 79	179	790.00	79	62410.00
80.	Item 80	180	800.00	80	64000.00
81.	Item 81	181	810.00	81	65610.00
82.	Item 82	182	820.00	82	67240.00
83.	Item 83	183	830.00	83	68890.00
84.	Item 84	184	840.00	84	70560.00
85.	Item 85	185	850.00	85	72250.00
86.	Item 86	186	860.00	86	73960.00
87.	Item 87	187	870.00	87	75690.00
88.	Item 88	188	880.00	88	77440.00
89.	Item 89	189	890.00	89	79210.00
90.	Item 90	190	900.00	90	81000.00
91.	Item 91	191	910.00	91	82810.00
92.	Item 92	192	920.00	92	84640.00
93.	Item 93	193	930.00	93	86490.00
94.	Item 94	194	940.00	94	88360.00
95.	Item 95	195	950.00	95	90250.00
96.	Item 96	196	960.00	96	92160.00
97.	Item 97	197	970.00	97	94090.00
98.	Item 98	198	980.00	98	96040.00
99.	Item 99	199	990.00	99	98010.00
100.	Item 100	200	1000.00	100	100000.00

Cinreraria Sprayed on April 6	Lot I.	Lot II.	Lot III.	Lot IV.
	Tips of leaves dried some.	Tips of leaves dried very little.	Tips dried as bad as those of Lot I.	O. K.
" 13	Little more so.	About the same.	Looks worse.	O. K.
" 20	Same as on 13th.	Looks better.	" still "	Leaves dried very little.
" 28	Same as on 13th.	" still "	No change.	Leaves look better.
May 4	Same as on 13th.	O. K.	" "	O. K.
Primula Sprayed on April 6	Looks some- what sickly.	Looks some better than Lot I.	O. K.	O. K.
" 13	Same.	Same as on 6th.	"	"
" 20	Leaves dry- ing up.	Improves some.	Leaves dried very little.	"
" 28	Leaves dried much more.	Same.	No change.	"
May 4	Leaves dried still more.	"	" "	"
Carnation. Sprayed on April 6	O. K.	O. K.	O. K.	O. K.
" 13	"	"	"	"
" 20	"	"	"	"
" 28	"	"	"	"
May 4	"	"	"	"
Petunia. Sprayed on April 6	O. K.	O. K.	O. K.	O. K.
" 13	"	"	"	"
" 20	"	"	"	"
" 28	"	"	"	"
May 4	"	"	"	"

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1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100
1	2	3	4	5	6	7	8	9	10	11	1																																																																																								

	Lot I.	Lot II.	Lot III.	Lot IV.
Strobilanthes Dyerianus. Sprayed on April 6	Wilted con-	O. K.	.O..K.	O. K.
" 13	siderably. Same.	"	Wilted some	"
" 20	Little better."		Not as bad	"
" 28	O. K.	"	Lot I 8th. Better.	"
May 4	"	"	O. K.	"

Ageratum Sprayed on April 6	O. K.	O. K.	O. K.	O. K.
" 13	"	"	"	"
" 20	"	"	"	"
" 28	"	"	"	"
May 4	"	"	"	"

Achyranthes Emersonii. Sprayed on April 6	Leaves dried. some.	O. K.	O. K.	O. K.
" 13	Looks better.	"	"	"
" 20	O. K.	"	"	"
" 28	"	"	"	"
May 4	"	"	"	"

Achyranthes Lindenii. Sprayed on April 6	O. K.	O. K.	O. K.	O. K.
" 13	"	"	"	"
" 20	"	"	"	"
" 28	"	"	"	"
May 4	"	"	"	"

[illegible]

Achyranthes Lot I.	Lot II.	Lot III.	Lot IV.
Hoveyii.			
Sprayed on			
April 6	O. K.	O. K.	O. K.
" 18	"	"	"
" 20	"	"	"
" 28	"	"	"
May 4	"	"	"

It will be noticed that there are some inconsistencies, especially in case of the *Primula* and *Strobilanthes Dyerianus* which may have been caused by a difference in individual plants.

Experiment II.

This experiment was similar to the preceding one with the exception that soft water was used and that but nine varieties were sprayed but three times.

Table 2.

Petunia	Lot I.	Lot II.	Lot III.	Lot IV.
Sprayed on				
April 20	Looks quite	Not thor-	O. K.	O. K.
	sickly. Not	oughly heal-		
	good color.	thy.		
" 28	No change.	No change.	"	"
May 4	" "	" "	"	"
<i>Cinmeraria.</i>				
Sprayed on				
April 20	Tips of	O. K.	O. K.	Looks about as
	leaves dried			bad as Lot I.
	some.			
" 28	Dried up	"	"	Look worse.
	more today.			
May 4	No further	"	"	Still worse.
	change.			

Verbena.	Lot I.	Lot II.	Lot III.	Lot IV.
Sprayed on				
April 20	Leaves dried some.	Same as Lot I.	Not quite as bad as Lot I.	O. K.
" 28	Looks some worse.	No change.	Looks much better.	"
May 4	No change.	" "	O. K.	"
Heliotrope.				
Sprayed on				
April 20	Looks somewhat sickly. Poor color.	O. K.	O. K.	O. K.
" 28	No change.	"	"	"
May 4	Improved some.	"	"	"

Coleus Verischaefelteii, Coleus Yellow Verischaefelteii, Achyranthes Lindii, Geranium, and Primula were also treated but with no change showing in any of the plants. This table is somewhat more satisfactory. The unsprayed Cinneraria evidently suffering from some outside influence.

Experiment III.

With this experiment ^{our} from lots of six varieties each were sprayed with Zenoleum of three strengths five times. Lot I with a solution of one part to 20 of water.

" II " " " " " " " 40 " "

" III " " " " " " " 60 " "

" IV was not sprayed at all.

It was noted that the plants in Lot III of the Stock, Cinneraria, Begonia, and Ageratum had been more or less affected so two more lots of these were secured and sprayed with a solution of one part to 80 of water and Lot VI with one part to 100 of water.

Geranium. Lot I. Lot
 Sprayed on
 April 6 O. K. O.

" 13 Has very " little good color.
 " 20 Leaves start- ing to dry up.
 " 28 Much worse. "

May 4 Many leaves " falling off.

Achyranthes
 Emersonii.
 Sprayed on
 April 6 O. K. O.

" 13 " "
 " 20 " "
 " 28 " "

May 4 " "

Stock.
 Sprayed on
 April 6 Bottom leaves Very yellowish. lea

" 13 Little worse, Near flowers wilt- of ed some. lea
 " 20 Much worse. Loc not
 " 28 No change. as No

May 4 " " "

.IV 30d

.X .0

Begonia.	Lot I.	Lot II	
Sprayed on			
April 6	Top of plant	Not q	
	and tips of	as ba	
	leaves black.	Lot I	
" 13	Most of	Plants	"
	plant turn-	ed bad	
	ing black.		
" 20	Leaves and	Leaves	"
	tips of	tips f	
	branches fall-	of	
	ing off.		
" 28	Dead.	All le	"
		dead a	
		tips.	
May 4.	---	Plant	"

Ageratum.			
Sprayed on			
April 6	Tips of plant	Wilted	
	wilted and	tips.	
	dried up some.		
" 13	Much worse.	Tips w	"
		and dr	
		some.	
" 20	Plants wilt-	Much w	"
	ed.		
" 28	Dead.	Still v	"
May 4	---	Dead.	"

Cinnyeraria.			
Sprayed on			
April 6	Tips of	Tips of	
	leaves dried	leaves	
	some.	very l	
" 13	Leaves worse,	Leaves	"
	flowers	more.	
	dried some.		
" 20	Worse.	Leaves	"
		ly wil	
" 28	Bad.	Whole	"
		wilted	
May 4	Dead.	Almost	"

• *Chlorophyll a* and *Chlorophyll b* were measured in the leaves of *S. purpurea* and *S. oleracea* grown in the greenhouse and in the field. The results showed that the chlorophyll content was higher in the leaves of *S. purpurea* than in the leaves of *S. oleracea* grown in the greenhouse and in the field.

11. *Chrysomelids* (Coleoptera: Chrysomelidae) (10 spp.)

[illegible][illegible]

1997, 1998, 1999, 2000, 2001, 2002, 2003, 2004, 2005, 2006, 2007, 2008, 2009, 2010, 2011, 2012, 2013, 2014, 2015, 2016, 2017, 2018, 2019, 2020, 2021, 2022, 2023, 2024, 2025, 2026, 2027, 2028, 2029, 2030, 2031, 2032, 2033, 2034, 2035, 2036, 2037, 2038, 2039, 2040, 2041, 2042, 2043, 2044, 2045, 2046, 2047, 2048, 2049, 2050, 2051, 2052, 2053, 2054, 2055, 2056, 2057, 2058, 2059, 2060, 2061, 2062, 2063, 2064, 2065, 2066, 2067, 2068, 2069, 2070, 2071, 2072, 2073, 2074, 2075, 2076, 2077, 2078, 2079, 2080, 2081, 2082, 2083, 2084, 2085, 2086, 2087, 2088, 2089, 2090, 2091, 2092, 2093, 2094, 2095, 2096, 2097, 2098, 2099, 2100, 2101, 2102, 2103, 2104, 2105, 2106, 2107, 2108, 2109, 2110, 2111, 2112, 2113, 2114, 2115, 2116, 2117, 2118, 2119, 2120, 2121, 2122, 2123, 2124, 2125, 2126, 2127, 2128, 2129, 2130, 2131, 2132, 2133, 2134, 2135, 2136, 2137, 2138, 2139, 2140, 2141, 2142, 2143, 2144, 2145, 2146, 2147, 2148, 2149, 2150, 2151, 2152, 2153, 2154, 2155, 2156, 2157, 2158, 2159, 2160, 2161, 2162, 2163, 2164, 2165, 2166, 2167, 2168, 2169, 2170, 2171, 2172, 2173, 2174, 2175, 2176, 2177, 2178, 2179, 2180, 2181, 2182, 2183, 2184, 2185, 2186, 2187, 2188, 2189, 2190, 2191, 2192, 2193, 2194, 2195, 2196, 2197, 2198, 2199, 2200, 2201, 2202, 2203, 2204, 2205, 2206, 2207, 2208, 2209, 2210, 2211, 2212, 2213, 2214, 2215, 2216, 2217, 2218, 2219, 2220, 2221, 2222, 2223, 2224, 2225, 2226, 2227, 2228, 2229, 2230, 2231, 2232, 2233, 2234, 2235, 2236, 2237, 2238, 2239, 2240, 2241, 2242, 2243, 2244, 2245, 2246, 2247, 2248, 2249, 2250, 2251, 2252, 2253, 2254, 2255, 2256, 2257, 2258, 2259, 2260, 2261, 2262, 2263, 2264, 2265, 2266, 2267, 2268, 2269, 2270, 2271, 2272, 2273, 2274, 2275, 2276, 2277, 2278, 2279, 2280, 2281, 2282, 2283, 2284, 2285, 2286, 2287, 2288, 2289, 2290, 2291, 2292, 2293, 2294, 2295, 2296, 2297, 2298, 2299, 2300, 2301, 2302, 2303, 2304, 2305, 2306, 2307, 2308, 2309, 2310, 2311, 2312, 2313, 2314, 2315, 2316, 2317, 2318, 2319, 2320, 2321, 2322, 2323, 2324, 2325, 2326, 2327, 2328, 2329, 2330, 2331, 2332, 2333, 2334, 2335, 2336, 2337, 2338, 2339, 2340, 2341, 2342, 2343, 2344, 2345, 2346, 2347, 2348, 2349, 2350, 2351, 2352, 2353, 2354, 2355, 2356, 2357, 2358, 2359, 2360, 2361, 2362, 2363, 2364, 2365, 2366, 2367, 2368, 2369, 2370, 2371, 2372, 2373, 2374, 2375, 2376, 2377, 2378, 2379, 2380, 2381, 2382, 2383, 2384, 2385, 2386, 2387, 2388, 2389, 2390, 2391, 2392, 2393, 2394, 2395, 2396, 2397, 2398, 2399, 2400, 2401, 2402, 2403, 2404, 2405, 2406, 2407, 2408, 2409, 2410, 2411, 2412, 2413, 2414, 2415, 2416, 2417, 2418, 2419, 2420, 2421, 2422, 2423, 2424, 2425, 2426, 2427, 2428, 2429, 2430, 2431, 2432, 2433, 2434, 2435, 2436, 2437, 2438, 2439, 2440, 2441, 2442, 2443, 2444, 2445, 2446, 2447, 2448, 2449, 2450, 2451, 2452, 2453, 2454, 2455, 2456, 2457, 2458, 2459, 2460, 2461, 2462, 2463, 2464, 2465, 2466, 2467, 2468, 2469, 2470, 2471, 2472, 2473, 2474, 2475, 2476, 2477, 2478, 2479, 2480, 2481, 2482, 2483, 2484, 2485, 2486, 2487, 2488, 2489, 2490, 2491, 2492, 2493, 2494, 2495, 2496, 2497, 2498, 2499, 2500, 2501, 2502, 2503, 2504, 2505, 2506, 2507, 2508, 2509, 2510, 2511, 2512, 2513, 2514, 2515, 2516, 2517, 2518, 2519, 2520, 2521, 2522, 2523, 2524, 2525, 2526, 2527, 2528, 2529, 2530, 2531, 2532, 2533, 2534, 2535, 2536, 2537, 2538, 2539, 2540, 2541, 2542, 2543, 2544, 2545, 2546, 2547, 2548, 2549, 2550, 2551, 2552, 2553, 2554, 2555, 2556, 2557, 2558, 2559, 2560, 2561, 2562, 2563, 2564, 2565, 2566, 2567, 2568, 2569, 2570, 2571, 2572, 2573, 2574, 2575, 2576, 2577, 2578, 2579, 2580, 2581, 2582, 2583, 2584, 2585, 2586, 2587, 2588, 2589, 2590, 2591, 2592, 2593, 2594, 2595, 2596, 2597, 2598, 2599, 2600, 2601, 2602, 2603, 2604, 2605, 2606, 2607, 2608, 2609, 2610, 2611, 2612, 2613, 2614, 2615, 2616, 2617, 2618, 2619, 2620, 2621, 2622, 2623, 2624, 2625, 2626, 2627, 2628, 2629, 2630, 2631, 2632, 2633, 2634, 2635, 2636, 2637, 2638, 2639, 2640, 2641, 2642, 2643, 2644, 2645, 2646, 2647, 2648, 2649, 2650, 2651, 2652, 2653, 2654, 2655, 2656, 2657, 2658, 2659, 2660, 2661, 2662, 2663, 2664, 2665, 2666, 2667, 2668, 2669, 2670, 2671, 2672, 2673, 2674, 2675, 2676, 2677, 2678, 26

3. *Conclusions*—The results of this study indicate that the use of a single, non-validated, questionnaire to assess the prevalence of musculoskeletal disorders in a population of health care workers is not sufficient to provide a reliable estimate of the prevalence of these disorders. The use of a single questionnaire may also be insufficient to provide information on the specific musculoskeletal disorders that are most prevalent in a population of health care workers. The use of a single questionnaire may also be insufficient to provide information on the specific risk factors for musculoskeletal disorders in a population of health care workers. The use of a single questionnaire may also be insufficient to provide information on the specific interventions that are most effective in reducing the prevalence of musculoskeletal disorders in a population of health care workers. The use of a single questionnaire may also be insufficient to provide information on the specific barriers to the implementation of interventions to reduce the prevalence of musculoskeletal disorders in a population of health care workers. The use of a single questionnaire may also be insufficient to provide information on the specific outcomes of interventions to reduce the prevalence of musculoskeletal disorders in a population of health care workers. The use of a single questionnaire may also be insufficient to provide information on the specific costs of interventions to reduce the prevalence of musculoskeletal disorders in a population of health care workers. The use of a single questionnaire may also be insufficient to provide information on the specific benefits of interventions to reduce the prevalence of musculoskeletal disorders in a population of health care workers. The use of a single questionnaire may also be insufficient to provide information on the specific barriers to the implementation of interventions to reduce the prevalence of musculoskeletal disorders in a population of health care workers. The use of a single questionnaire may also be insufficient to provide information on the specific outcomes of interventions to reduce the prevalence of musculoskeletal disorders in a population of health care workers. The use of a single questionnaire may also be insufficient to provide information on the specific costs of interventions to reduce the prevalence of musculoskeletal disorders in a population of health care workers. The use of a single questionnaire may also be insufficient to provide information on the specific benefits of interventions to reduce the prevalence of musculoskeletal disorders in a population of health care workers.

11. The following table shows the results of the regression analysis for the dependent variable "Number of children" (N = 1,000). The independent variables are "Age" (in years) and "Gender" (Male/Female). The regression equation is: $Y = 0.5X_1 + 0.2X_2 + 0.1$, where Y is the number of children, X_1 is age, and X_2 is gender (1 for Male, 0 for Female).

[illegible][illegible]

1997, 1998, 1999, 2000, 2001, 2002, 2003, 2004, 2005, 2006, 2007, 2008, 2009, 2010, 2011, 2012, 2013, 2014, 2015, 2016, 2017, 2018, 2019, 2020, 2021, 2022, 2023, 2024, 2025, 2026, 2027, 2028, 2029, 2030, 2031, 2032, 2033, 2034, 2035, 2036, 2037, 2038, 2039, 2040, 2041, 2042, 2043, 2044, 2045, 2046, 2047, 2048, 2049, 2050, 2051, 2052, 2053, 2054, 2055, 2056, 2057, 2058, 2059, 2060, 2061, 2062, 2063, 2064, 2065, 2066, 2067, 2068, 2069, 2070, 2071, 2072, 2073, 2074, 2075, 2076, 2077, 2078, 2079, 2080, 2081, 2082, 2083, 2084, 2085, 2086, 2087, 2088, 2089, 2090, 2091, 2092, 2093, 2094, 2095, 2096, 2097, 2098, 2099, 2100, 2101, 2102, 2103, 2104, 2105, 2106, 2107, 2108, 2109, 2110, 2111, 2112, 2113, 2114, 2115, 2116, 2117, 2118, 2119, 2120, 2121, 2122, 2123, 2124, 2125, 2126, 2127, 2128, 2129, 2130, 2131, 2132, 2133, 2134, 2135, 2136, 2137, 2138, 2139, 2140, 2141, 2142, 2143, 2144, 2145, 2146, 2147, 2148, 2149, 2150, 2151, 2152, 2153, 2154, 2155, 2156, 2157, 2158, 2159, 2160, 2161, 2162, 2163, 2164, 2165, 2166, 2167, 2168, 2169, 2170, 2171, 2172, 2173, 2174, 2175, 2176, 2177, 2178, 2179, 2180, 2181, 2182, 2183, 2184, 2185, 2186, 2187, 2188, 2189, 2190, 2191, 2192, 2193, 2194, 2195, 2196, 2197, 2198, 2199, 2200, 2201, 2202, 2203, 2204, 2205, 2206, 2207, 2208, 2209, 2210, 2211, 2212, 2213, 2214, 2215, 2216, 2217, 2218, 2219, 2220, 2221, 2222, 2223, 2224, 2225, 2226, 2227, 2228, 2229, 2230, 2231, 2232, 2233, 2234, 2235, 2236, 2237, 2238, 2239, 2240, 2241, 2242, 2243, 2244, 2245, 2246, 2247, 2248, 2249, 2250, 2251, 2252, 2253, 2254, 2255, 2256, 2257, 2258, 2259, 2260, 2261, 2262, 2263, 2264, 2265, 2266, 2267, 2268, 2269, 2270, 2271, 2272, 2273, 2274, 2275, 2276, 2277, 2278, 2279, 2280, 2281, 2282, 2283, 2284, 2285, 2286, 2287, 2288, 2289, 2290, 2291, 2292, 2293, 2294, 2295, 2296, 2297, 2298, 2299, 2300, 2301, 2302, 2303, 2304, 2305, 2306, 2307, 2308, 2309, 2310, 2311, 2312, 2313, 2314, 2315, 2316, 2317, 2318, 2319, 2320, 2321, 2322, 2323, 2324, 2325, 2326, 2327, 2328, 2329, 2330, 2331, 2332, 2333, 2334, 2335, 2336, 2337, 2338, 2339, 2340, 2341, 2342, 2343, 2344, 2345, 2346, 2347, 2348, 2349, 2350, 2351, 2352, 2353, 2354, 2355, 2356, 2357, 2358, 2359, 2360, 2361, 2362, 2363, 2364, 2365, 2366, 2367, 2368, 2369, 2370, 2371, 2372, 2373, 2374, 2375, 2376, 2377, 2378, 2379, 2380, 2381, 2382, 2383, 2384, 2385, 2386, 2387, 2388, 2389, 2390, 2391, 2392, 2393, 2394, 2395, 2396, 2397, 2398, 2399, 2400, 2401, 2402, 2403, 2404, 2405, 2406, 2407, 2408, 2409, 2410, 2411, 2412, 2413, 2414, 2415, 2416, 2417, 2418, 2419, 2420, 2421, 2422, 2423, 2424, 2425, 2426, 2427, 2428, 2429, 2430, 2431, 2432, 2433, 2434, 2435, 2436, 2437, 2438, 2439, 2440, 2441, 2442, 2443, 2444, 2445, 2446, 2447, 2448, 2449, 2450, 2451, 2452, 2453, 2454, 2455, 2456, 2457, 2458, 2459, 2460, 2461, 2462, 2463, 2464, 2465, 2466, 2467, 2468, 2469, 2470, 2471, 2472, 2473, 2474, 2475, 2476, 2477, 2478, 2479, 2480, 2481, 2482, 2483, 2484, 2485, 2486, 2487, 2488, 2489, 2490, 2491, 2492, 2493, 2494, 2495, 2496, 2497, 2498, 2499, 2500, 2501, 2502, 2503, 2504, 2505, 2506, 2507, 2508, 2509, 2510, 2511, 2512, 2513, 2514, 2515, 2516, 2517, 2518, 2519, 2520, 2521, 2522, 2523, 2524, 2525, 2526, 2527, 2528, 2529, 2530, 2531, 2532, 2533, 2534, 2535, 2536, 2537, 2538, 2539, 2540, 2541, 2542, 2543, 2544, 2545, 2546, 2547, 2548, 2549, 2550, 2551, 2552, 2553, 2554, 2555, 2556, 2557, 2558, 2559, 2560, 2561, 2562, 2563, 2564, 2565, 2566, 2567, 2568, 2569, 2570, 2571, 2572, 2573, 2574, 2575, 2576, 2577, 2578, 2579, 2580, 2581, 2582, 2583, 2584, 2585, 2586, 2587, 2588, 2589, 2590, 2591, 2592, 2593, 2594, 2595, 2596, 2597, 2598, 2599, 2600, 2601, 2602, 2603, 2604, 2605, 2606, 2607, 2608, 2609, 2610, 2611, 2612, 2613, 2614, 2615, 2616, 2617, 2618, 2619, 2620, 2621, 2622, 2623, 2624, 2625, 2626, 2627, 2628, 2629, 2630, 2631, 2632, 2633, 2634, 2635, 2636, 2637, 2638, 2639, 2640, 2641, 2642, 2643, 2644, 2645, 2646, 2647, 2648, 2649, 2650, 2651, 2652, 2653, 2654, 2655, 2656, 2657, 2658, 2659, 2660, 2661, 2662, 2663, 2664, 2665, 2666, 2667, 2668, 2669, 2670, 2671, 2672, 2673, 2674, 2675, 2676, 2677, 2678, 26

Experiment VI.

This experiment was the spraying of the following shrubs and trees with a soft water solution of copper sulphate strength 1-1000 and Zenoleum 1-60 on April 20th, 28th, and May 4th.

Hard Maple. Soft Maple. Sycamore. White Pine. Lilac. Cork Elm. Arbor Vitae. Honey Suckle. Norway Spruce. Box Elder. Buffalo Currant. Sumac. Golden Elder. Ampelopsis Veitchii. Virginia Creeper.

No effect was noticed from the copper sulphate solution but the Zenoleum killed the leaves on the Ampelopsis Veitchii and the Virginia Creeper.

At this same time I sprayed the peach, pear, plum, apple and cherry with this same solution of Zenoleum and with a copper sulphate solution of twice the strength as used on the other trees, that is a solution 1 to 500. Here too, there was no effect except in the case of the pear. Here the leaves were badly injured especially the smaller ones. The older ones dried up in spots but were less seriously injured.

Experiment V.

This experiment consisted in spraying strawberries, gooseberries, blackberries, raspberries, currants, potatoes, peas, beans, lettuce, cucumbers, and radishes with copper sulphate 1-1000 and Zenoleum 1-60. The copper sulphate did not affect any of the plants but the Zenoleum affected the lettuce, cucumbers, peas, and beans in order named. All recovered however and there was no apparent difference excepting these plants were somewhat later in maturing than those not sprayed.

Experiment VI.

In this experiment I endeavored to find the relative values of Bordeaux Mixture and Copper Sulphate as preventives of Anthracnose, Apple Scab, Pear Leaf Blight, and Rust on Carnations and Strawberries by spraying five times (on June 23, July 2, 9, 13, 21,) with a soft water solution of copper sulphate 1-600 and with Bordeaux Mixture.

The young shoots of Cuthbert Raspberries were sprayed for anthracnose but as so little anthracnose showed itself on either the sprayed or unsprayed plants no conclusion could be drawn.

Pears were sprayed in a like manner for Pear Leaf Blight. It was found that the Copper Sulphate was injuring the foliage to such an extent that it would be impracticable to use it longer. Believing that possibly some mistake had been made Peas, Apples, Plums, and Cherries were sprayed with solution 1-600 and 1-1200. These were sprayed but twice but the same injurious effect was noticed on the peas sprayed with the solution 1-600, while those sprayed with the 1-1200 solution were not affected at all. The other fruits were not hurt in the least by this spraying. No leaf blight has shown itself on any of the trees sprayed or unsprayed.

A Fameuse apple tree was sprayed in a similar manner and the results were very marked. The Copper Sulphate solution diminished the number of cases of scab very much, also the severeness with which it attacked the apple.

The Bordeaux Mixture was even more beneficial than the Copper Sulphate. It is safe to say that it diminished the

number of scabby apples at least one-half. It also made the scab very much weaker than those where there was no spraying done. Two varieties of strawberries (Pawnee and Swindle) were sprayed in a similar manner for the fungus *Sphaerotheca*. Here the results were very apparent indeed, the sprayed plants in many cases being almost free from the fungus. The Copper Sulphate seemed to be somewhat superior to the Bordeaux Mixture in this experiment as those sprayed with Copper Sulphate seemed to be somewhat freer from the fungus.

Spraying showed a decided improvement in the amount of rust on carnations. The Copper Sulphate was fully as good here as was the Bordeaux Mixture.

It is thus shown that the Copper Sulphate is of considerable value for spraying apples for scab, of equal value with Bordeaux Mixture on carnations, and fully as valuable, if not more so, than Bordeaux Mixture on strawberries.

Experiment VII.

This experiment consisted in spraying different plants five times at intervals of about one week to see if a solution of Zenoleum would kill various insect pests. By a previous experiment it had been found that Zenoleum could not be safely used on plants stronger than one part to sixty of water, so this strength was used. Begonias were sprayed for the scab *Aecidium hesperidum*; Crotons for the Mealy Bug (*Dactlopius*), Red Spider, Thrip, and the fungus *Fumago-vagans*; a Sago Palm for the scab *Aecidium olea*; a Spiral Pine for the fungus *Fumago-vagans*; Chrysanthemums for Black Aphis;

Cactus for the scale (*Aspidiotus cacti*); and an apple tree for the scale known as *Mitalispis pomorium*.

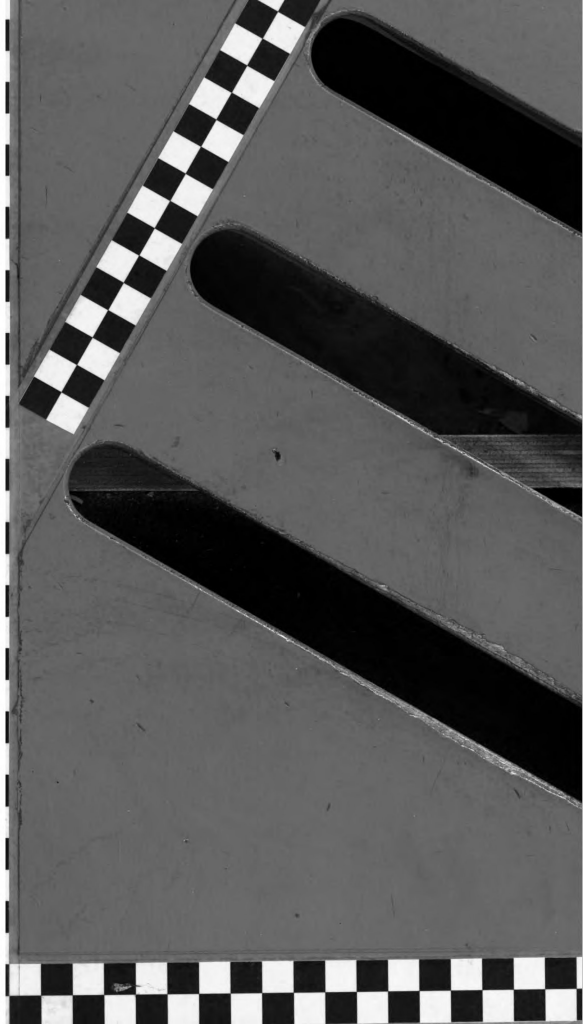
It was shown very conclusively that this solution will not kill the *Pumago-vagans* fungus, the mealy bug, red spider, and black aphid. It did however kill the thrip and the *Lecanium olea* scale, and greatly reduced the scale on the cactus and apple. However it seems to be impracticable for those two scales for it was not effectual enough to compensate for the time and expense of spraying.

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