CONTROL OF PINEAPPLE MEALY-BUG WILT*

INTRODUCTION

PINEAPPLE mealy-bug wilt is by far the most destructive malady known to affect the pineapple plant, *Ananas comosus* (Linn.) Merr., particularly Smooth Cayenne, which is considered the premier commercial variety. It is characterized by a general wilting of the plant, with or without green spotting on the leaves. It assumes a number of forms depending upon the age, the succulence, and the vigor of the plant, as well as the size and time of onset of the initial mealy-bug infestation. A large population at the onset of the initial mealy-bug infestation produces quick wilt, while a small number of insects produces slow wilt. The younger and the more succulent and vigorous the plant is, the quicker it succumbs to quick wilt.

Pineapple mealy-bug wilt is caused by the toxic secretion of the pineapple mealy-bug, *Pseudococcus brevipes* (Ckll.)[4]. It is found everywhere the Smooth Cayenne pineapple is grown, causing almost complete collapse of the entire field, in several instances. While much has already been said by various investigators about its destructiveness, etc., no definite information about its control is given in any of the available literature on the subject. In view of this and its economic importance, attempts were made immediately after its true cause was known to find ways and means to control it or at least to check its spread.

HOW PINEAPPLE MEALY-BUG WILT SPREADS

Full knowledge of how the malady spreads is of prime importance in devising means of control. A more or less exhaustive investigation of the matter was therefore made, and it was ascertained that the pineapple mealy-bug may be disseminated in three ways; namely, through infested plant material, through the agency of ants, and to some extent, through its own volition.

When plant material such as crowns or tops, slips, suckers, stumps, seedlings, and fruits are removed from an infested field without previous treatment for pineapple mealy-bug control, the pest may be introduced to new fields. This practice is in fact responsible for the rapid spread of the malady.

Another sure way of spreading the pest is through the aid of two species of ants, *Pheidole megacephala* (Fabr.) and *Solenopsis geminata* Fabr. var. *rufa* Jerdon, which feed on the honey-dew secreted by the mealy-bug and which, in return, take care of the young mealy-bugs.

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The pineapple mealy-bug may also invade, although to a very limited extent, new pineapple plants through its own volition. It can crawl from leaf to leaf and from plant to plant. This is especially true with the gray strain or the green-spotting type [4] which does not seem to like remaining very long in one spot.

SPRAYING EXPERIMENTS

The spraying experiments for the control of the pineapple mealy-bug were carried out in the pineapple fields of the Philippine Packing Corporation situated at Santa Fe, Bukidnon Province, Mindanao, from January to September, 1930. That year was climatically speaking unusually dry for that locality. It was, nevertheless, favourable for the mealy-bugs and, fortunately, also for spraying.

EXPERIMENT 1

Materials and Methods.—To find out the best insecticide for the control of the pineapple mealy-bug the efficacy and feasibility of soapsuds spray, nicotine-soap spray, and oil-emulsion spray were tested. The experiment was laid out in January, 1930, on thirty-six double rows of standard length of 4-month-old Hawaiian Smooth Cayenne variety, spaced 56 by 22 by 18 inches. The plants were uniform in size and general vigor, with more or less uniform mealy-bug infestation, but showed no signs of wilt at the time.

The block was divided into three parts of twelve rows each. The first part was treated by spraying with 2 per cent. soap-suds rows 1 to 3 and 7 to 9 at monthly and bimonthly intervals, respectively, for four months, leaving rows 4 to 6 and 10 to 12 unsprayed as check. The second part instead was treated similarly with nicotine soap for rows 13 to 15 and 19 to 21, and with oil emulsion for rows 25 to 27 and 31 to 33, leaving the rest unsprayed as check. By means of a compressed-air spray pump all of the plants except the check were sprayed one by one, each leaf thoroughly wetted, and the spray material driven between the closely appressed leaves and the heart especially, where an abundance of the mealy-bugs is found.

Results.—At the close of the experiment observations on the general health and vigor of the plants were made. The results are presented in Table 1.

It is shown in Table 1, first, that the mealy-bug wilt of pineapple may be checked by spraying with either soapsuds, nicotine soap, or oil emulsion; second, that monthly application is more effective than bimonthly application; and third, that these sprays are practically the same in efficiency, soapsuds having 73·9 per cent.; nicotine soap, 77·2 per cent.; and oil emulsion 83·3 per cent. efficacy. The wilting of some of the sprayed plants may, perhaps, be explained by the fact that when the spraying was started several of the plants had already heavy mealy-bug infestation, although no signs of wilt were visible at the time. Had the spraying been started earlier or before the mealy-bugs got well established, better results might have been obtained.

An after-effect of the treatment noticed is the scorching of the leaves sprayed with either nicotine soap or oil emulsion. Such harmful effect is, however, much more pronounced in the latter, in many instances causing decay of the heart or terminal bud of the plant. Unfortunately the injury does not become manifest until after a month or so. The decay of the heart induces the plant to branch off in the form of five or more suckers, the production of which delays the maturing of the crop.

Table 1.—Showing comparative efficacy of soapsuds, nicotine soap, and oil emulsion for the control of pineapple mealy-bug wilt

Rows	Treatment	Spraying intervals	Observations		Efficiency
			Healthy	Wilting	
					Per cent.
1-3	Soapsuds	Monthly	1,200	60	80·0
4-6	Check	—	960	300	—
7-9	Soapsuds	Bimonthly	1,165	95	67·7
10-12	Check	—	966	294	—
Average	—	—	—	—	73·9
13-15	Nicotine soap	Monthly	1,215	45	84·5
16-18	Check	—	969	291	—
19-21	Nicotine soap	Bimonthly	1,167	93	69·9
22-24	Check	—	951	309	—
Average	—	—	—	—	77·2
25-27	Oil emulsion	Monthly	1,221	39	87·0
28-30	Check	—	960	300	—
31-33	Oil emulsion	Bimonthly	1,200	260	79·6
34-34	Check	—	966	294	—
Average	—	—	—	—	83·3

EXPERIMENT 2

Owing to the cheapness, handiness, availability, and especially the efficacy of soapsuds spray, which proved to be practically as high as that of either nicotine soap or oil emulsion, it was decided to ascertain the best way to attain the most satisfactory results with it. Laboratory tests (the inclusion of which is deemed unnecessary) clearly showed that of the various brands of laundry soap, Senorita is the one that compares most favourably with Chinese Yellow in efficacy. Chinese White and Lenox are practically the same. Because Senorita soap has a more stable and more reliable consistency than Chinese Yellow, it was chosen for all subsequent experiments of this series as well as others in which soap is the main constituent of the spray solution.

Materials and Methods.—This experiment was laid out in April, 1930, on fifty-four double rows (56 by 22 by 18 inches) of 4-month-old Hawaiian Smooth Cayenne plants in the pineapple fields of the Philippine Packing Corporation, at Santa Fe, Bukidnon, showing uniformity in general stand and vigor as well as in the distribution and extent of the pineapple mealy-bug infestation. Soapsuds in three dilutions, 1, 1·5, and 2 per cent., were

employed in three different series; that is, as plain soapsuds, as soapsuds with brown pottery clay, and as hot soapsuds. Solutions of the various concentrations were prepared from a 10 per cent. stock solution.

Starting with plain soapsuds, plants of rows 1 to 3 were sprayed thoroughly, one by one, with 1 per cent. solution; rows 7 to 9, with 1·5 per cent.; and rows 13 to 15, wtih 2 per cent., leaving rows 4 to, 6, 10 to 12 and 16 to 18 unsprayed as check.

With the compressed-air pump spraying was done monthly for from two to five months, depending on the prevalence of the mealy-bugs. The remaining rows were treated in like manner but with soapsuds containing 0·2 per cent. brown pottery clay, for rows 19 to 21, 25 to 27, and 31 to 33, and plain soapsuds heated to from 45° to 50°C. for rows 37 to 39, 43 to 45, and 49 to 51, while the other rows, 22 to 24, 28 to 30, 34 to 36, 40 to 42, 46 to 48, and 52 to 54, remained unsprayed as check.

Results.—The observations made at the close of the experiment are presented in Table 2.

Table 2.—Showing increase in the relative efficacy of soapsuds of different concentrations caused by the addition of clay and by heating

Rows	Treatment	Concentration	Applications	Observations		Efficiency
				Healthy	Wilting	
		Per cent.				Per cent.
1-3	Soapsuds, plain	1·0	5	1,180	80	72·9
4-6	Check	—	—	965	295	—
7-9	Soapsuds, plain	1·5	4	1,197	63	79·0
10-12	Check	—	—	959	301	—
13-15	Soapsuds, plain	2·0	3	1,202	58	80·4
16-18	Check	—	—	963	297	—
Average		—	—	—	—	77·5
19-21	Soapsuds plus 0·2 per cent. clay	1·0	4	1,193	67	77·5
22-24	Check	—	—	962	298	—
25-27	Soapsuds plus 0·2 per cent. clay	1·5	3	1,200	60	80·0
28-30	Check	—	—	960	300	
31-33	Soapsuds plus 0·2 per cent. clay	2·0	2	1,200	60	79·6
34-36	Check	—	—	966	294	—
Average		—	—	—	—	79·0
37-39	Soapsuds, 45-50°C	1·0	3	1,195	65	77·6
40-42	Check	—	—	970	290	—
43-45	Soapsuds, 45-50°C	1·5	2	1,200	60	79·9
46-48	Check	—	—	962	298	—
49-51	Soapsuds, 45-50°C	2·0	2	1,202	58	80·7
52-54	Check	—	—	960	300	—
Average		—	—	—	—	79·4

Table 2 shows that the optimum concentration of soapsuds for the control of pineapple mealy-bug wilt seems to lie between 1·5 and 2 per cent., and that the addition of 0·2 per cent. brown pottery clay or heating the solution to from 45° to 50°C. renders the soapsuds more effective. These facts are indicated by the number of applications needed by each treatment, by the number of healthy and diseased plants, and by the average percentage of efficiency. As in the first experiment it was also noted that the plants that came out diseased in the sprayed rows are those which have had more or less heavy mealy-bug infestation, although they showed no signs of wilt when the experiment was started.

In field practice one of the things tried to make the spray more effective and giving satisfactory results was to brush the mealy-bugs off with a long-handled brush, simultaneously with spraying. High pressure was also found to contribute to the effectiveness of the spray. The higher the pressure at which the spray is delivered the quicker and the surer the mealy-bugs are stripped of their woolly and waxy covering, hence the quicker they succumb to the treatment.

DIPPING EXPERIMENTS

While spraying is necessary for the control of pineapple mealy-bug wilt once the pest has gained foothold in the field, greater emphasis must be placed on using only mealy-bug-free plant material (suckers, slips, crowns, etc.), particularly in starting new plantations. This was clearly demonstrated by the check plants used in the infestation experiments.[4] Whenever possible plant material should be obtained only from mealy-bug-free fields. If the plantations are infested, however, efforts should be made to select the plant material from mealy-bug-free individuals. Otherwise effective treatment of some kind, like dipping, must be resorted to before setting out the plants.

As it has been shown conclusively in the writer's earlier article [4] that pineapple mealy-bug wilt is caused by the pineapple mealy-bug *Pseudococcus brevipes* (Ckll.), it is axiomatic that the exclusion of the insect will prevent the malady. It was felt to be of prime importance, therefore, to search for an effective means by which the plant material could be freed from the mealy-bugs, granting that such plant material was infested. In the preceding spraying experiments it was revealed that soapsuds are just as good as, if not better than, either nicotine soap or oil emulsion for the control of the pineapple mealy-bug, because of their handiness, cheapness, feasibility, stability and high order of efficacy. The following experiments, started in November 1, 1930, in Santa Fe, Bukidnon Province, were designed to explore the suitability of soapsuds as a dipping solution.

EXPERIMENT 3

Materials and Methods.—Three different concentrations of soapsuds were prepared; namely, 44 liters of 1 per cent., 44 liters of 1·5 per cent., and 44 liters of 2 per cent.; each solution was divided into four equal parts and kept in empty gasoline cans. Stumps of wilting 8-month-old Smooth Cayenne plants showing mealy-bugs in abundance were collected and trimmed. Nine of such stumps were immersed in the first solution;

three of them were "fished out" after 10 minutes, three after 20 minutes, and the remaining three after 30 minutes, and each batch was placed in a separate, properly labelled, enamelled pan with the lips lined with Tanglefoot preparation to prevent ants from taking away any mealy-bugs that might survive the treatment. The same number of stumps were treated similarly in the second solution, another batch in the third solution, and still another in the fourth, the latter two solutions being kept at a temperature ranging between 54° and 55° C. during the treatment. This completes the tests in the first series of 1 per cent. solution. Tests on the remaining two series of 1·5 per cent. and 2 per cent. solutions were carried out in exactly the same manner and with the same number and kind of stumps infested with an abundance of pineapple mealy-bugs. Care was taken to make the conditions of the experiment in all essentials as nearly identical as possible throughout the whole series.

Results.—The following day the stumps of the three series were examined minutely, one by one, with the help of a binocular for the mealy-bugs present, dead or alive. The results are given in Table 3.

Table 3 shows that for the control of pineapple mealy-bug wilt soapsuds are more effective with pottery clay than without, and that their efficacy is increased by more than twice when the solution is heated to and maintanied at a temperature of 54° to 55°C. during the treatment. It is also shown that at room temperature 1 per cent. is as ineffective as either 1·5 per cent. or 2 per cent. but when used at 54° to 55°C. they are equally effective, rendering mealy-bug-infected stumps absolutely free from the infestation in ten minutes if 0·2 per cent. pottery clay is added to the solution, and in twenty minutes if no pottery clay is added.

Another point brought out by these results is that in spraying 1·5 per cent. soapsuds gives 100 per cent. killing power or efficiency, whereas preparations at even higher concentrations are practically useless as dipping solutions unless applied hot. In order, therefore, that a spraying solution of given concentration may be effective as a dipping solution it must be used hot. It is pertinent, perhaps, to mention in this connection that heat alone at a temperature of 54° to 55°C. does not kill the mealy-bugs; when infested plant specimens were immersed in tap water at the same temperature for the same duration, none of the mealy-bugs was killed.

EXPERIMENT 4

It has been amply demonstrated in the preceding experiments that soapsuds of any reasonable concentration are not sufficiently effective as a dipping solution for the control of the pineapple mealy-bug unless used hot. It was desirable, therefore, to find out the best temperature and time exposure for each type of pineapple plant material.

Materials and Methods—Ninety liters of 1·5 per cent. soapsuds were prepared and divided equally in six empty gasoline cans numbered from 1 to 6. Solution 1 was heated, and upon reaching the temperature of 39° to 40°C., at which it was maintained, nine trimmed stumps of 8-month-old wilting Smooth Cayenne plants were immersed in it; three of them were "fished out" after 40 minutes, three after 50 minutes

Table 3.—The number of living and the number of percentage of dead mealy-bugs found on each plant material after dipping in unheated and hot soap solution of different concentrations with and without the addition of pottery clay

Solution	Concentration	Temperature	Duration of exposure in minutes									Average efficacy
			10			20			30			
			Alive	Dead	Efficacy	Alive	Dead	Efficacy	Alive	Dead	Efficacy	
	Per cent.	°C.			Per cent.			Per cent.			Per cent.	Per cent.
Soapsuds, plain	1·0	26-27	545	165	23·2	801	384	32·4	490	370	43·0	32·8
Soapsuds plus 0·2 per cent. clay	1·0	26-27	490	268	35·3	472	326	40·8	288	376	56·6	44·2
Soapsuds, plain	1·0	54-55	6	534	88·8	0	540	100·0	0	330	100·0	96·3
Soapsuds plus 0·2 per cent. clay	1·0	54-55	0	652	100·0	0	504	100·0	0	589	100·0	100·0
Soapsuds, plain	1·5	26-27	574	222	37·9	491	391	44·3	285	312	52·2	41·4
Soapsuds plus 0·2 per cent. clay	1·5	26-27	440	274	38·3	356	364	50·5	240	420	63·6	50·8
Soapsuds, plain	1·5	54-55	10	579	98·3	0	490	100·0	0	712	100·0	99·4
Soapsuds plus 0·2 per cent. clay	1·5	54-55	0	712	100·0	0	489	100·0	0	605	100·0	100·0
Soapsuds, plain	2·0	26-27	405	262	37·7	584	418	41·7	286	384	57·3	45·6
Soapsuds plus 0·2 per cent. clay	2·0	26-27	496	336	40·3	432	382	46·9	204	432	67·9	51·7
Soapsuds, plain	2·0	54-55	5	657	99·2	0	620	100·0	0	718	100·0	99·7
Soapsuds plus 0·2 per cent. clay	2·0	54-55	0	543	100·0	0	477	100·0	0	490	100·0	100·0

and the last three after 60 minutes, and each set was placed separately in an enamelled basin with lips lined with Tanglefoot preparation to prevent ants from taking away any mealy-bug that might survive the treatment. After this, three batches consisting of nine suckers weighing about 150 grams each, nine slips of about 100 grams each, and nine crowns of about 50 grams each were treated similarly, one by one, while the temperature of the soap solution was maintained at 30° to 40°C. The same kinds and number of plant materials were treated, in an identical manner, but with one series at 42° to 43°C., one at 45° to 46°C., one at 48° to 49°C., one at 51° to 52°C., and another at 45° to 55°C.

Table 4.—The number of living and the number and percentage of dead mealy-bugs found on each plant material and the degree of scorching of each kind of plant material after immersion in 1·5 per cent. soap solution at different temperatures and exposures.

Group	Temperature of solution	Exposure.	Stumps			Observations		
			Alive	Dead	Efficacy	Suckers, ± 150 grams each	Slips, ± 100 grams each	Crowns, ± 50 grams each.
	°C.	Min.			Per cent.			
1	39-40	40	18	1,720	97·8	Normal	Normal	Normal
	39-40	50	16	1,940	99·2	do	do	do
	39-40	60	0	1,595	100·0	do	do	do
2	42-43	40	9	1,416	99·3	do	do	do
	42-43	45	6	1,992	99·7	do	do	do
	42-43	50	0	1,566	100 0	do	do	do
3	45-46	30	14	1,445	99·0	do	do	Slightly scorched
	45-46	35	0	1,427	100·0	do	do	do
	45-46	40	0	1,507	100·0	do	do	do
4	48-49	15	16	1,501	98·8	do	Severely scorched	Severely scorched
	48-49	20	0	1,776	100·0	do	do	do
	48-49	25	0	1,522	100·0	do	do	do
5	51-52	10	17	1,129	98·5	Severely scorched	do	do
	51-52	15	0	1,577	100·0	do	do	do
	51-52	20	0	1,757	100·0	do	do	do
6	54-55	5	13	1,220	98·9	do	do	do
	54-55	10	0	1,566	100·0	do	do	do
	54-55	15	0	1,518	100·0	do	do	do

Results.—The following day all of the stumps were minutely examined, one by one, under a binocular, and the mortality of the mealy-bugs present on each noted. This having been completed, all of the shoots and crowns were gone over, group by group, the next day, for any sign of scorching that the treatment might have produced thereon, and classified as normal, slightly scorched, or severely scorched, as the case might be. The results are given in Table 4.

It is shown in Table 4 that a 100 per cent. killing of the pineapple mealy-bugs can be effected by soaking the plant material 60 minutes in soapsuds of 1·5 per cent. concentration with 0·2 per cent. brown pottery clay at a temperature of 39° to 40°C., 50 minutes at 42° to 43°C., 35 minutes at 45° to 46°C., 20 minutes at 48° to 49°C., 15 minutes at 51° to 52°C., and 10 minutes at 54° to 55°C. It is also shown that

suckers weighing about 150 grams each can withstand soaking for 20 minutes at 48° to 49°C. without danger of becoming scorched; slips weighing about 100 grams each, for 35 minutes at 45° to 46°C. and crowns weighing about 50 grams each, for 50 minutes at 42° to 43°C. It is quite evident from these results that pineapple plant material of all types may be freed from mealy-bug infestation by soaking in hot 1·5 per cent. soap solution, in the following order:

Stumps, 15 minutes 51° to 52°C.

Suckers, 150 grams, 20 minutes at 48° to 49°C.

Slips, 100 grams, 35 minutes at 45° to 46°C.

Crowns, 50 grams, 50 minutes at 42° to 43°C.

Seedlings, small, 60 minutes at 39° to 40°C.

The results of both spraying and dipping expeirments as presented in the preceding tabulations become more significant in the light of Carter's[1] revelation of the results of his laboratory and field tests in dipping and spraying for mealy-bug control in Hawaii, stating among other things, that various commercial oil emulsions provide a satisfactory means of control, although the susceptibility of the plants to scorching imposes severe restrictions on their use. The writer found this to be so when comparison between the efficiency of soapsuds, nicotine soap, and oil emulsion for the same purpose was made.

VACUUM FUMIGATION

Another possibility to render the plant material free from the mealy-bugs is vacuum fumigation. That this possibility merits consideration is shown by the report of Hagan [3] in Hawaii, that vacuum fumigation with hydrocyanic acid gas at the rate of 10 ounces sodium cyanide to 1,000 cubic feet of space for one to one and one-half hours and 28 inches of vacuum at the start, gave satisfactory results. Similar treatment with either carbon bisulphide or chlorpicrin resulted, however, in great injury to the plant material.

SCOUTING

Scouting to locate the focus of infestation is of fundamental importance and should go hand-in-hand with spraying. In fact it should precede spraying. This is especially necessary when plants are still young and the mealy-bugs not yet well established. Its usefulness cannot be over-emphasized considering the fact that the malady does not become conspicuous until after the infestation has gone too far to respond to drastic and costly treatment. An early discovery of its occurrence is of fundamental value. This can be effected by proper scouting under trained personnel at least once a month.

NATURAL ENEMIES AND PREDATORS

The pineapple mealy-bug has a number of natural enemies and predators, such as the brown lacewing sympherobid, *Sympherobius augustus*; the ladybird beetle, *Cryptolaemus montrouzieri* Muls.; *Lobodiplosis pseudococci* Felt; [2] and a grasshopper, *Conocephalus saltator* Sauss. The

first two were introduced from Hawaii by the Philippine Packing Corporation, in 1930, in Bukidnon Province, Mindanao. Efforts should be made to encourage the rapid multiplication and spread of such benefactors, for under ordinary conditions they should be able to hold the mealy-bugs under control.

ANT CONTROL

While there are natural enemies and predators attacking the pineapple mealy-bug, there are also on the other hand insects protecting it. Two species of ants, *Pheidole megacephala* (Fabr.) and *Solenopsis germinata* Fabr. var. *rufa* Jerdon are known to do this. They feed on the honey dew secreted by the mealy-bug whose young they protect in return from enemies. Keeping these ants under check will therefore not only enhance the activities of the natural enemies and predators of the pineapple mealy-bug but will also adversely affect the general vigor and fecundity of the mealy-bug itself.

Controlling these ants, particularly the red variety, *Solenopsis geminata* Fabr. var. *rufa* Jerdon, is not an easy matter. However, clean culture and surface mulching by harrowing the ground of the plantation, whenever possible, may help in driving them away. Simple soapsuds spray as employed for the mealy-bug treatment is effective and cheap enough to use for the black ant, *Pheidole megacephala* (Fabr.), which may be killed in its dugouts by pouring the solution into the holes. The red ant, on the other hand, never appears greatly concerned when treated with any of the three insecticides which proved destructive to the mealy-bug. Fumigants like chlorpicrin, carbon bisulphide, and hydrocyanic acid gas may prove effective in the control of both ants, and their applicability should be carefully and thoroughly studied.

BORDER PLANTING

On the assumption that new fields planted to mealy-bug-free seeds are adjacent to infested old fields, border planting as supplementary means of checking the malady seems advisable. This would tend to slow down the influx of the mealy-bugs migrating from a mealy-bug-laden field, and to localize infestation, thereby facilitating spraying operations. Border planting to be effective must consist of a bed of at least four rows and the plants must be as succulent and vigorous as those in the main plantation so as to provide enough inducement for the mealy-bug to remain. These conditions are necessary for detaining the insect in the border planting and effectively checking its advance.

SUMMARY

1. It has been observed that the pineapple mealy-bug wilt may be disseminated in a number of ways; namely, through infested plant material, such as suckers, slips, crowns, etc., through ants, and through the mealy-bug's own volition.

2. Field tests have been shown that the pineapple mealy-bug wilt may be controlled by spraying about once a month with 1·5 per cent. soap solution. The addition of pottery clay (about 0·2 per cent.) preferably the brown type, renders the solution more effective.

3. Nicotine-soap solution and oil emulsion have proved to be practically as effective as soapsuds, if not more so, in killing the pineapple mealy-bug. Owing, however, to their scorching effect on plants, which is quite serious, particularly in the case of oil emulsions, their application is considered rather precarious. Hence, soap solution is considered preferable.

4. Laboratory tests have shown that of the different brands of laundry soap tried the Chinese Yellow has the highest efficiency, followed closely by the Senorita. The Chinese White and the Lenox are practically of the same strength.

5. For dipping purposes soapsuds at any reasonable concentration are practically worthless unless used hot, as follows: Stumps, 15 minutes at 51° to 52°C.; suckers about 150 grams, 20 minutes at 48° to 49°C.; slips, about 100 grams, 35 minutes at 45° to 46°C.; crowns, about 50 grams, 50 minutes at 42° to 43°C.; seedlings, 60 minutes at 39° to 40°C. Complete freedom from the pineapple mealy-bug is secured by dipping infested plant material in 1·5 per cent. soap solution at these temperatures and corresponding time exposures. One-hundred-and-ninety-liter barrels or large vats equipped with heaters may be used for this purpose.

6. As in spraying, the addition of pottery clay (about 0·2 per cent.), preferably the brown type, renders the dipping solution more effective, while heating to 45° to 50°C. increases its efficacy more than twice.

7. Proper scouting to locate the focus of infestation is necessary for successful spraying. It is especially needed in young plantations where the mealy-bug colonies may actually become established rapidly although no outward manifestations of the malady are yet shown.

8. Quick reproduction and spread of the pineapple mealy-bug's natural enemies and predators—such as, *Synipherobius augustus Cryptolaemus montrouzieri* Muls., *Lobodiplosis pseudococci* Felt, and *Conocephalus saltator* Sauss.—should be studied and the results obtained thereform disseminated among pineapple growers.

9. Keeping under check the ants *Pheidole megacephala* (Fabr.) and *Solenopsis geminata* Fabr. var. *rufa* Jerdon, which are in symbiotic association with the pineapple mealy-bug, *Pseudococcus brevipes* (Ckll.), will materially help in keeping the malady under control.

10. In starting new plantations in districts where the malady is more or less well established border planting is a necessary precaution, particularly when ants are abundant.

11. The need for using nothing but mealy-bug-free plant material in opening new plantations cannot be overemphasized. This may be accomplished by either selecting plant material from mealy-bug-free fields or properly treating the mealy-bug-infested plant material prior to planting.

REFERENCES

1. CARTER, W.—The use of insecticides on pineapple plants in Hawaii. Journ. Econ. Ent. 24 (1931) 1233-1242.

2. FELT, E. P.—A new enemy (*Lobodiplosis pseudococci* sp. nov.) of the pineapple mealy-bug (*Pseudococcus brevipes* (Ckll.), in Hawaii) and a list of gall midge enemies of mealy-bugs Journ. N.Y. Ent. Soc. 61 (1933) 119-123.

3. HAGAN, H. R.—Vacuum fumigation of pineapple planting material. Journ. Econ. Ent. 24 (1931) 1002-1012.

4. SERRANO, F. B.—Pineapple mealy-bug wilt in the Philippines. Philip. Journ. Sci. 55 (1934) 363-377.