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Department of Entomology

THE CODLING MOTH

By J. M. ALDRICH

TIMES-DEMOCRAT JOB ROOM
MOSCOW, IDAHO.

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BULLETINS

The regular bulletins of the Station are sent free to all citizens of Idaho who request them
Late Bulletins are:

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THE CODLING MOTH.

By J. M. ALDRICH.

In beginning a discussion of our experiments and studies on the codling moth, it is necessary to repeat a few facts quite well-known about its life-history. The insect under consideration is the common worm of the apple, which when full-grown becomes a small gray moth. Eggs are laid by the moth, which hatch into worms again. These feed in the apples until ready to change into the next brood of moths. This explains the use of the word "brood"; that is, it is one complete generation of the insect, from the egg to the moth. The eggs from these moths would be the first stage of the next brood. The number of broods of worms in a season is not everywhere the same; as will be shown further on, it is generally two in Idaho, but in some places is three.

The insect winters in the worm or larva form, enclosed in a cocoon, and concealed under loose bark on an apple tree, or in some shelter near the tree. In the spring about the time that apples bloom it sheds its skin and becomes a brown chrysalis (also called the pupa), without any free external organs, but with the developing parts of the moth within. In two weeks or so the moth breaks the brown shell of the chrysalis and emerges. The eggs are laid some few days later, which on hatching constitute the *first brood* of worms. These will be found entering the apples about a month after the blossoms have fallen. They do not all enter at the same time, but continue to hatch for three weeks or more. The main bulk of them will be in the apples within two weeks from the time that they become notice-

able, however. The reason of so much difference in the time of entrance of the worms is found chiefly in the fact that the overwintered worms do not all mature at the same time, some emerging as moths much before the others; another cause is that some moths lay sooner than others after emerging. Then again, some eggs hatch sooner than others. So the wonder is that the worms of the first brood keep as near together as they do in the time of their development.

The worms become full-grown in about a month from the time of entrance into the apple. They then crawl out and down the branch, or sometimes they drop to the ground by a silken thread. They spin their cocoons in the same sort of shelter as the worm that winters, rough bark on the trunk of the tree being a favorite place. Here they pass through the pupa stage in about two weeks, and then the moths emerge, which are the last stage of the first brood. These soon lay their eggs, and these hatch in a few days into the *second brood* of worms, which develop in the apples as the first did.

In most parts of the state, this second brood of worms, after reaching full size and making their cocoons, do not develop any farther that season, but winter over as larvæ in the cocoons. Hence there are said to be two broods of the codling moth in those sections. It will be shown farther on in this bulletin that in other parts of the state these second-brood worms go on and mature the same season, lay their eggs, and the *third brood* of worms results, which winters in cocoons as the second does in other places. The existence of this third brood is an important matter to understand, and the confusion about it has necessitated a full explanation.

APPLE-GROWING REGIONS OF IDAHO.

While almost all the arable land of Idaho will raise apples, there are conditions of climate and altitude which define four main regions, which may be located and defined as follows:

Southwestern Idaho.—The main acreage in this region is between Boise and Weiser, following the valley of the Boise from the point where it leaves the foothills to its mouth; the Payette valley from Horseshoe Bend is included, also the lower Weiser,

and the orchards along the Snake from Shoshone Falls to Huntington. The towns of Shoshone, Mountain Home and Orchard, with their adjacent territory, belong to this region. Altitude, 2,500 to 3,500 ft.

This is by far the most important apple-shipping section of the state at the present time; probably three-fourths of the apples marketed outside of the state the last season were shipped from this region.

The damage done by the codling moth is generally severe; unsprayed orchards, except those which are young and isolated, will have from 50 to 100 per cent of the remaining apples wormy in the fall at picking time.

On account of the important financial interest involved, and the difficulty of carrying on continuous work in a section so far from the State Experiment Station, the entomologist urgently requested Dr. L. O. Howard, U. S. Entomologist, to send an agent from the Division of Entomology to study the codling moth in southwestern Idaho. Hon. Edgar Wilson, at that time member of Congress from Idaho, actively seconded the project, and secured a special appropriation for it. Dr. Howard granted the request, and detailed Mr. C. B. Simpson for the work. Mr. Simpson finished up his studies and experiments this past fall, after three seasons' work, and the Department of Agriculture will publish the results in a short time. The methods which he used with great success will be mentioned in a paragraph farther on in this bulletin. He found that there are but two broods of the moth in this region.

Southeastern Idaho.—This region extends from American Falls up the Snake River Valley into Fremont county, and also includes the cultivated parts of Oneida and Bear Lake counties. Altitude, 3,500 to 4,500 ft., except about near Bear Lake, where it is 6000.

The climate of this section is colder than that of the previous one, in proportion to the increased altitude. Still, the apple is raised in all the older settlements, even in those about Bear Lake, where they also have occasional worms in the fruit. In many parts of this region, no apple trees have come into

bearing yet, hence there are no worms; there are no places known to the writer where the moth can be called a serious pest as yet. Whether the present immunity is only due to the newness of the orchard industry, time will tell; probably in the warmer sections such is the case. It is not likely, however, that the moth will ever be very abundant outside the warmer parts of southeastern Idaho. The number of broods has not been worked out, but there is every reason to suppose that it is two.

Northern Idaho.—The non-irrigated arable part of northern Idaho shows considerable variation of altitude, soil and climate, but may be placed in one section for our present purpose. It includes the eastern side of the "Palouse Country," of which the western part lies across the state line in Washington; the "Potlatch Country" about Kendrick and Juliaetta, except a small acreage near the bottom of the canyons; the "Camas Prairie," about Grangeville, Cottonwood and Denver; the higher part of Nez Perce county, commonly referred to as the "Reservation;" and a considerable area in Kootenai county, east and northeast of Spokane. The last-named section has an altitude of but little over 2000 ft.; the remainder varies from 2,500 to 3,500 ft.

In quantity of apples raised, perhaps this region equals southwestern Idaho; but it falls considerably behind in quanity shipped as well as in the price obtained. The codling moth is not nearly so serious a pest here as in the former region. At Moscow, careful observations have been made for several years at picking-time, to determine the per cent of apples wormy, with the following result:

YEAR.	NO. TREES	TOTAL APPLES	NO. WORMY	PER CENT WORMY
1899	40	8200	1720	21.0
1900	7	1432	184	12.8
1901	23	11035	542	4.8
1902	9	5888	654	11.1

These trees were unsprayed, except a part of those included in the count for 1901, which had received one application early in the season; but, as they were more wormy than the unsprayed

trees counted, it was considered that this spray had had no appreciable effect.

In all northern Idaho, including Lewiston, the first brood of worms is much fewer than in southwestern Idaho. In the latter region, over half of the apples on some trees examined were wormy Aug. 8, before the second brood had hatched. At the same time in North Idaho the damage was one-tenth of one per cent at Moscow, two per cent at Lewiston, and from 13 to 21 at Kendrick and Juliaetta. The Moscow record would be fairly representative of the Palouse country in general, as the place agrees better in altitude.

From this and many other facts, which have been collected and studied in the past eight or nine years, I have come to the conclusion that the reason for the small number of worms in the Palouse country is that the insects do not winter successfully in our climate. It seems that very few survive to establish the first brood of the following season. In the vicinity of Boise, on the other hand, the first brood seemed last year to be fully as numerous as the second, showing that many worms had survived the winter.

Lewiston.—The irrigated valleys of the Clearwater and Snake in the immediate vicinity of Lewiston constitute a horticultural section by themselves, distinguished by warm temperature and low altitude. Most of the orchard land has an elevation of 600 or 700 ft., but in some tributary valleys, notably of the Potlatch up to Juliaetta, many of the same characteristics extend up to an altitude of 1000 ft.

As compared with the other orchard regions just mentioned, the Lewiston region has a small acreage; but the climate allows the production of such fine and early fruit that the prices received are much above those obtained in other parts of Northern Idaho. On account of the advantage of earliness and consequent high price, in raising cherries, peaches, pears, etc., the apple is less raised than formerly in the Lewiston valley. No new orchards are being put out, and the old ones are gradually being replaced with the higher-priced fruit. Hence the codling moth

is becoming of less importance here; although it must be confessed that the enormous damage done by the worm has been a factor of no little importance in determining the substitution of other fruit for the apple. Unsprayed apple-trees generally have a loss of from 90 to 100 per cent wormy at picking time. This applies to winter apples; summer apples, as they ripen very early, escape a large part of the damage. There is excellent reason to believe that there are three broods of the codling moth in this valley, as will be shown below.

While the damage here is about the same as in southwestern Idaho, it is differently distributed in the season, the first brood of worms being few, and the third doing much damage; while in the latter region the first brood does fully half of the damage, and there is no third brood.

Life history studies in 1902.—In order to ascertain whether there is a third brood of the moth in North Idaho, and if so how it is affected by the great differences in altitude that exist, four stations for study and experiment were selected for the season. These were as follows:

Lewiston, S. G. Isaman's orchard,	altitude		700 ft.
Juliaetta, E. H. Minden's	"	"	1300 ft.
Kendrick, G. J. Farmer's	"	"	2000 ft.
Moscow, W. N. Gibb's	"	"	2700 ft.

The orchard of E. H. Minden is located on a low bench a little above the level of Juliaetta, and distant a mile and a half from the town; the Farmer orchard is on a high bench on the Pine Creek side of Big Bear Ridge, five miles from Kendrick.

In these orchards an effort was made to trace the life history of the moth throughout the season. This was most nearly accomplished at Lewiston and Juliaetta. At Moscow the number of worms was so extremely small that no satisfactory progress could be made, and but a few records were established.

Spring was late in opening, and there was less heat than usual throughout the summer. In an average season the dates mentioned below would probably be two weeks earlier for the fore part of the season, and even more for the latter part.

At Lewiston the following record of facts was made:

The blossoms had fallen from the apple-trees and the calyces were still open on May 10. On June 19 the first worms were found to be entering the apples. In an adjoining orchard they seemed to have entered a little earlier, for in that orchard the larvæ under bands changed to pupæ just before July 6, being fresh on that date. At this time a large number of wormy apples were placed in a breeding cage to rear the moths. The first moths matured on July 14; the first eggs deposited by them in the cage were on July 22 and 23. On July 31 an inspection of the Isaman orchard showed that the first brood of worms had left the apples and the second had not yet commenced to enter. There were some apples on the trees that showed worm-holes, but the worms were all gone. At this time I left directions with Mr. Isaman to pick fifty wormy apples in about ten days, when the second brood would be in the apples, and put them in the breeding cage. This he did. By this method I am satisfied we had the second brood, and not the first, as the apples picked had only small worms in them, and there had previously been a distinct interval between the two broods, corresponding with the period indicated by the breeding-cage. The worms of the second brood gave moths, commencing Sept. 3 and 4. On Sept. 6, for the purpose of an experiment in late spraying, all the wormy apples were picked off from a number of Ben Davis trees, leaving only sound fruit. All apples affected by the first brood of worms had been picked off in July, in counting up results of early spray; they had been only two or three per cent of the crop. The apples picked off the second time were not counted, but Mr. Isaman estimated they were fully 60 per cent of what were on the trees. In the latter part of October, the remaining apples on these trees were picked and counted; two unsprayed trees gave 52 per cent wormy, and four once-sprayed trees gave 44 per cent, showing that a heavy loss had taken place, which in my opinion was almost wholly chargeable to the third brood.

Since there has been much doubt on the part of experiment station workers as to the existence of a third brood, and the question is one making a very material difference in the treatment of orchards, it seems worth while to mention a few additional

facts bearing on this brood at Lewiston.

In the season of 1900, Mr. Isaman sprayed his orchard after the blossoms fell, and thereafter at intervals of 10 days: six weeks: ten days: six weeks: ten days. Part of the orchard did not receive the last two sprays. About September 15, Professor Henderson, the botanist of the Experiment Station, called at his place, and in company with Mr. Isaman, examined the results of the spray. They looked over a number of trees, and both concluded that the loss by worms was about two per cent.

On September 21 of the same season, barely a week later, I called at Mr. Isaman's and he asked me to go with him into the orchard and see the splendid results of his spraying for the codling month. This I did; but to Mr. Isaman's chagrin, the apples were simply riddled with a new brood of worms, of nearly uniform size, and evidently hatched within a few days; as many as 13 of the small holes were found in a single apple, though some of these did not contain worms.

Here was a clear case of a new brood of worms developing after Sept. 15. It was remarkable, and I presume quite unusual, in not being scattered over a longer interval of time. But it certainly would be out of the question to suppose that a portion of the second brood could have been delayed to this time of year, and then appear simultaneously in such numbers. At the time of this occurrence, the existence of a third brood had not been called in question, and no further explanation was sought than to call them the third brood.

In this connection we may consider the length of time normally required for a generation or brood of the moth to develop. This has been definitely ascertained by Mr. Simpson to be on the average about fifty days at Boise. At Lewiston it would certainly not be any longer, and might possibly be a very few days less. In 1902, the worms were entering the apples at Lewiston on June 19, and probably a little earlier in some places. Fifty days would bring us to Aug. 8 as the time for the next brood to enter. This would be over two weeks later than the time of laying the first eggs in the breeding-cage, so it would certainly be late enough; as a matter of fact, Aug. 5 would be nearer the act-

ual date But taking Aug. 8 and adding another fifty days brings us to Sept. 27, 1902. Considering the very marked lateness of the spring in 1902, I think that this date corresponds remarkably well with the brood that entered Mr. Isaman's apples Sept. 16–21, 1900, when the season was not so late.

Experiments carried on by Professor Cordley and Mr. Simpson, in the Willamette Valley and the vicinity of Boise respectively, indicate that the larvae of the second brood in those sections do not pass into the pupa state the same season, but winter as larvae and pupate the following spring. It is a very well-known fact that the insect does not winter in the pupa state. Hence I consider that it is pretty good evidence of a third brood, if it can be shown for any locality that the larvae of the second brood do pass into the pupa stage. However, the preceding facts not only show so much, but they show the date of hatching of the third brood, and the amount of damage done by it.

At the Juliaetta station, Mr. Minden's orchard, the third brood did not manifest itself very distinctly. Apple trees were in condition for the first spraying (blossom fallen and calyx open) on May 22, about ten days later than at the Lewiston Station.

The first worms entering apples were just prior to June 26, say about June 24. On July 8 there were 22 worms under bands on 4 trees, indicating that there must have been worms entering considerably earlier than I thought. There is something of a discrepancy here, as also at Lewiston, due I suppose to the fact that it is much easier to overlook the first worm entering the apple than the first worm coming under the band.

On Sept. 13, fifty apples containing nearly mature worms of the second brood were placed in the breeding-cage under an apple tree. These were examined Oct. 10; the cage had apparently been opened in the meantime, as one empty pupa-case was found but no moth. The rest of the worms had made cocoons, but were still in the larval condition, indicating that they would not change until the next spring. At this time there were a few very young larvae in the apples, which may have been of the third brood.

At Kendrick and Moscow, no indication of a third brood

were noted. The first moth matured in the breeding-cage on Aug. 9 and 14 respectively, which would indicate that the first of the second brood of worms would not enter the apples until the latter part of the month.

SPRAYING EXPERIMENTS OF 1902.

These were carried out in four parallel series at the stations already mentioned. In all about three hundred trees were sprayed; after dropping a number of these which proved for various reasons unsuited for the experiments, and adding a liberal number of adjacent unsprayed trees at each place, there were 378 trees, bearing slightly over 100,000 apples, which were carefully studied at the proper season, all the apples examined, and the per cent wormy recorded. Of these trees, 239 had been sprayed, and 139 were unsprayed, being used as checks on the experiment.

The objects of the work were the following:

1.—To make a comparison of the effectiveness of Paris green with arsenate of lead.

2.—To compare one application of poison at the time the blossoms fall with one application made just before the worms enter the apple, which is a full month later.

3.—To compare each set of trees sprayed as just described with parallel sets that were sprayed twice, once at the time that the blossoms fell and again just before the entrance of the worms.

It was expected that the results of these experiments, made as they were at stations differing so much in climate, would indicate whether, in North Idaho and the Palouse country generally, the codling moth can be kept in check by one or two sprayings, which has been the general policy in the higher altitudes hereabouts. No experiments were made with a large number of sprayings, as that method has become fully established in the lower altitudes. The effort was to find if possible a less expensive and laborious method for the sections where the moth is less injurious.

As the effect of spraying at this time of year would be nearly all shown on the first brood of worms, the results were counted up as soon as all of this brood had had plenty of time to en-

ter the apples, and considerably before there was any danger of the beginning of the second brood. This was about July 15 for Lewiston, and correspondingly later for the other stations.

Results at Lewiston.—These may be briefly passed over, as the very small number of worms on unsprayed trees prevented any decided results. It turned out that the orchard used in the experiment had considerably fewer worms in the early part of the season than usual for it, and also fewer than in an adjoining orchard the same season.

SPRAY USED	DATE	NO. OF VARIETIES	TOTAL APPLES	NUMBER WORMY	PER CENT WORMY
Paris green	May 10	9	7920	95	1.2
Arsen. lead	" "	9	9343	129	1.4
Paris green	May 10 and June 19	3	3804	6	0.16
Arsen. lead	" " "	5	2023	38*	1.9
Paris green	June 19	6	5820	118	2.0
Arsen. lead	" "	5	4441	102	2.3
Unsprayed	Unsprayed	6	18335	327	1.7

* 14 on one tree, 13 on another.

The difficulty in drawing conclusions from a case where the worms are very few is well illustrated here. In several instances, a comparatively large number of worms on one or two trees, due to some cause that we could not trace, made such a change in the average of its class as to give a misleading result; as where it appears in the above table that the application on June 19 increased the number of worms over those on unsprayed trees.

Results at Juliaetta.—Of the trees sprayed and counted here, it was found necessary to omit a large part from the summing up. This was due to the fact that some were of undetermined variety, some had very few apples, and others were of a variety of no commercial importance but greatly subject to the attack of worms. The Ben Davis trees were readily recognized,

had a fair crop of fruit, and were numerous enough to show the desired comparisons; hence the table below refers only to that variety.

SPRAY USED	DATE	NO. OF TREES	TOTAL APPLES	NUMBER WORMY	PER CENT WORMY
Paris green	May 24	6	1065	76	7.1
Arsen lead	" "	6	755	54	7.1
Paris green	May 24 and June 26	7	1031	74	7.2
Paris green	June 26	4	820	94	11.5
Unsprayed	Unsprayed	6	1113	236	21.2

Results at Kendrick.—The orchard contained several varieties in rows north and south. The spraying was done east and west, so that each test was on a mixture of varieties, mainly Ben Davis, Missouri Pippin, and Rome Beauty. In counting the results some trees were omitted, but care was taken to use the same variety in each row, as far as possible.

SPRAY USED	DATE	NO. OF TREES	TOTAL APPLES	NUMBER WORMY	PER CENT WORMY
Paris green	May 31	9	5205	126	2.4
Aren. lead	" "	12	3992	251	6.3
Paris green	May 31, July 1	10	5203	55	1.0
Arsen. lead	" " "	8	3709	253	6.8
Paris green	July 1	11	4675	178	3.8
Arsen. lead	" "	7	2391	283	11.8
Arsen. lead	" 8	10	3884	318	8.2
Unsprayed	Unsprayed	11	3980	520	13.1

Results at Moscow.—These may be very briefly passed over, as there were no worms to speak of, and hence no results. All the sprayed trees are grouped together, regardless of treatment.

36 sprayed trees, 8004 apples, 2 wormy, per cent being 0.025.

11 unsprayed trees, 2923 apples, 3 wormy, per cent being 0.1.

CONCLUSIONS FROM SPRAYING EXPERIMENTS.

Value of Lead Arsenate.—In each case, the Paris green was used in the proportion of one pound to 160 gallons of water. The arsenate of lead was made by separately dissolving four ounces of arsenate of soda and eleven ounces of acetate of lead, then putting them in 100 gallons of water.

It will be noted that in the three comparative tests at Lewiston and the three at Kendrick, the arsenate of lead was considerably below Paris green in effectiveness in every case; at Juliaetta, in a single test, the results wers the same, but were poor for both kinds of spray. This seems to show that there is no advantage in the use of arsenate of lead.

One advantage claimed for this poison is that it adheres better than Paris green, and is not washed off so readily by rain. It so happens that a heavy rain fell July 2, 3 and 4, just after the second spray had been applied at Kendrick. The total precipitation was 2.19 inches at Moscow, as determined by the observer at the Experiment Station. On July 8, the Kendrick orchard was again visited, and as it proved that the second brood had not even yet commenced to enter the apples, a new set of trees was sprayed with arsenate of lead, in order to compare them with those sprayed once just before the rain. As will be noted in the Kendrick table, the trees sprayed July 8 with arsenate of lead had 8.2 per cent of the apples wormy, while those sprayed July 1 before the rain had 11.8 per cent and unsprayed trees had 13.1 per cent; showing plainly that a large part of the poison had been washed off by the rain. Trees sprayed with Paris green July 1 had only 3.8 per cent wormy, notwithstanding the rain, which would seem to indicate that Paris green is not only more effective in destroying worms, but also more resistant to rain, than arsenate of lead.

Comparison of Different Methods of Spraying.—Omitting the Moscow series on account of the absence of worms, it is found that the results at the other three places all agree in one respect,—the spray which was applied just after the blossoms fell did more good than the one applied about a mohth later, as the worms were about to enter the apples. This is in accordance with the eastern theory of spraying, as set forth in Slingerland's bulletin of the Cornell University Experiment Station.

At the same time, none of the results of single sprayings are good enough to be satisfactory on a commercial scale, in an orchard moderately infested with worms. The best results show the destruction of about four-fifths of the worms of the first brood; other experiments destroyed only two-thirds or one-half. In any of these cases, there would still be a considerable second brood of worms.

The value of two sprayings is not conclusively shown; in the Kendrick experiments the result was quite good, only one per cent of the apples being wormy, while at Juliaetta the second application seemed to have no effect. The Lewiston results must be accepted with caution, on account of the very small per cent shown; as far as they show anything, they indicate a good result from the second spray.

Briefly the main conclusions are as follows:

1. Arsenate of lead is inferior in all respects to Paris green.
2. The first spray should be made just after the blossoms fall, in spite of the fact that the worms do not enter for a month or more.
3. One application of spray is not sufficient where there are worms in appreciable numbers, so as to make any spraying necessary.
4. Whether two applications will be sufficient is not clearly shown by the results.

RECOMMENDATIONS FOR SPRAYING.

Materials for Spraying.—At the present time, scarcely any poisons are used against the codling moth in the northwest except Paris green and the "Kedzie formula" of white arsenic. Par-

is green requires no preparation; it is added to water in the proportion one pound to 160 gallons, and about two pounds of fresh lime to the same quantity, to insure against injury to foliage.

The "Kedzie formula," slightly modified from the original, is as follows:

White arsenic 1 lb.
Sal soda 2 lbs.
Water 1 gallon.

Directions.—Boil together until the arsenic is dissolved (about fifteen minutes). Add as much water as has boiled away, so as to have one gallon of the compound. Use one pint of this with three pounds of lime in a barrel of water (40 to 50 gallons.)

Mr. E. L. Smith, President of the Oregon Board of Horticulture, varies this formula by making a pint and a half of the arsenic solution. with six pounds of lime;—the latter in this case being supposed to act as a whitewash in holding the poison to the foliage.

Times to Spray.—In all cases the first application should be just after the blossoms fall, before the calyx or 'blossom end' of the apple has closed. The work of Mr. Simpson at Boise, last summer showed conclusively that three applications after this one, at intervals of three weeks, will give almost complete protection, without banding or auxiliary methods, in southwestern Idaho. In the Lewiston region, however, on account of the existance of the third brood of worms in late summer, there must be more spraying in the late part of the season. I would suggest spraying about August 25 and September 15, in addition to the four earlier applications.

In the remainder of northern Idaho, wherever there are worms enough to necessitate spraying, I recommend four applications, as at Boise. The efforts so far made, as mentioned in this bulletin, to control the moth in the Palouse country with one or two sprayings have not given results which justify the commercial use of such a method.

Since the northern Idaho region is much more variable in

altitude and in damage by the moth than either of the others mentioned, careful attention and study are required of each orchardist, in order that he may know whether it will probably pay him to spray for the moth. There are some orchards in which neither worms nor scab have produced any perceptible damage; it is not necessary to spray these. If it becomes necessary to spray for the scab, as is quite generally the case already in this section, then the poison for the moth could be added, exactly the same as if to so much water. There is no extra expense on account of treating the worms, except for the poison, as it adds nothing to the expense of making the application; and an orchard would have to be very free of worms beforehand to render this outlay unprofitable.

How to Spray.—This part of the subject is far from unimportant. The success that has been attained in handling the codling moth in the large commercial orchards of Boise, Idaho, and Hood River and Rogue River, Oregon, is considerably due to the methods used.

A large, powerful, pump, with which a strong pressure can be maintained, is the first requsite. A pressure guage is very useful, and costs only three or four dollars extra. If hand power is used, a pressure of fifty to seventy-five pounds is generally all that can be maintained; with gasoline or steam power, a hundred pounds is about the right figure.

The nozzle should not be too fine. With this heavy pressure, a fine nozzle gives such a fog-like spray that it cannot be thrown a yard from the instrument. The Bordeaux type of nozzle, opened far enough so that it will throw a torrent of small drops eight or ten feet, at a hundred pounds pressure, was used by Mr. Simpson's Boise experiment; and it seems to give the best results. The "very fine mist-like spray" that was formerly advocated by all entomologists, is not the thing wanted. A much coarser spray covers the foliage better, even if some drips off.

Orchardists wishing further advice may obtain it by addressing the Experiment Station.

ACKNOWLEDGMENTS.

I have adopted the results of Mr. Simpson's work at Boise, in advance of their full presentation in his report, which will soon be printed by the Department of Agriculture, and should be obtained by every orchardist in southwestern Idaho.

I am under obligations to Messrs. S. G. Isaman, E. H. Minden, and George J. Farmer for much assistance in the work done at Lewiston, Juliaetta and Kendrick respectively.

The counting of apples was done principally by L. A. Turley, a senior student in the University of Idaho. The remainder was done by W. W. Yothers, also a senior in the University.