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POISONING THE POTATO BEETLE.

F. H. HALL, W. H. JORDAN, F. C. STEWART AND H. J. EUSTACE.

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POPULAR EDITION*

OF

BULLETIN NO. 267.

POISONING THE POTATO BEETLE.

F. H. HALL.

Poison must be used on potatoes.

Since the advent of the Colorado potato beetle some thirty years ago it has usually been impossible to raise a good crop of potatoes in the East without a vigorous campaign against this insect. On small areas, or on larger ones in especially favorable years, hand picking may keep the "bugs" in check; but usually on large fields the labor cost of hand picking is prohibitive and poison must be used. For this purpose paris green was for years the one remedy recommended; and though other arsenicals have recently taken its place to a limited extent it is still the main standby of the potato grower.

Arsenicals occasionally injurious.

Now, soluble arsenic is almost as harmful to plants as to animals or insects; and since paris green always contains a small percentage of arsenic not completely combined with a base, and may contain, when not properly made, a considerable proportion of such soluble material, it is not surprising that it has occasionally burned the foliage of the potato plants to which it was applied.

*This is a brief review of Bulletin No. 267 of this Station on the Effect of Certain Arsenites on Potato Foliage, by W. H. Jordan, F. C. Stewart and H. J. Eustace. Any one specially interested in the detailed account of the investigations will be furnished, on application, with a copy of the complete bulletin. The names of those who so request will be placed on the Station mailing list to receive future bulletins, popular or complete as desired. Bulletins are issued at irregular intervals, as investigations are completed, not monthly.

The leading authorities have for years recommended that this and other arsenical poisons be used in lime water, or, better, in bordeaux mixture, so that any soluble arsenious acid might combine with the lime and thus become harmless to foliage. But many growers still continue to dust on the poison or to sprinkle it on mixed with water alone; and such users sometimes suffer from burned foliage. For this reason there has, lately, been considerable complaint about paris green and much hesitancy about applying it to potatoes. The advocates of certain non-arsenical "potato-bug" destroyers have not been slow to use the results of wrong application of paris green as arguments against its use at all.

Paris green safe when properly used.

But if injury from misuse were to prevent all use of materials, we would be obliged to discard many valuable agents. If paris green and other arsenicals are injurious only under certain conditions we should learn to control the conditions, not discard the poisons; for these materials are far cheaper than the non-arsenical substitutes proposed for them.

To ascertain to what extent paris green is injurious to potato foliage, how the injury is caused and under what conditions it occurs, a careful test was made at the Station in 1904. The results were surprising in several ways. There was no injury from the paris green, however applied; and the poison was found to have considerable power as a fungicide as well. That is, the rows on which paris green was used suffered much less from late blight than did check rows from which the bugs were picked by hand, and gave much larger yields.

Methods of applying paris green.

The dry, or powder gun, method of applying paris green is inexpensive, but it is not considered as effectual as spray treatment, so it was not included in the test. The poison was applied in water, in lime water and in bordeaux mixture, the rows thus treated lying side by side; while a row on one side was left unsprayed as a check, and a row on the other side was sprayed with bordeaux mixture only, these two rows being kept free from bugs by hand picking. This series of five rows was repeated five times so that each treatment was used on one-tenth of an acre of potatoes.

The plants were sprayed five times between July 7 and August 25, the spraying being done very thoroughly with a knapsack sprayer, going out one side of a row and back the other.

Poison was omitted at the last treatment as the foliage of the rows not treated with bordeaux was so badly injured by blight at that time that no paris green injury could have been detected. One pound of the poison was used to each 50 gals. of liquid. The paris green was analyzed in the Chemical Laboratory and found to be of good average quality, well representing the material generally found in market in the State. The amount of spraying liquid applied varied from 125 gals. at the first treatment to 225 gals. at the fourth. This gave from 2½ to 4½ lbs. of paris green to the acre at each application, and a total during the season of 12 lbs. to the acre. In the lime-water mixture, 2 lbs. of freshly slaked lime was used for each 50 gals. of water. The bordeaux was made by the usual 6–4–50 formula (1–to–8 strength) except in one spraying when 6 lbs. of lime was unintentionally used instead of 4 lbs. The poison was added to the bordeaux without using any more lime.

Results of test.

The potato beetles were perfectly controlled on all the rows. As already stated, there was no evidence of foliage burning by the paris green,—not even when the poison was used in water alone and at the rate of 4½ lbs. to the acre. On the contrary, all through the season the foliage on the two rows sprayed with poison in water and in lime-water was noticeably more free from blight, more perfect, greener and more vigorous than that on adjoining check rows from which the bugs were picked by hand. It was quite evident that the paris green was aiding the plants to resist blight, though of course to a less extent than did the bordeaux mixture on the other two rows of each series. There was no noticeable difference between the foliage of rows on which lime was used and those on which the poison was used in water alone ; nor was there any contrast between the bordeaux-sprayed rows, with and without paris green.

Digging time, however, brought out more strongly the advantage of the paris green ; and indicated that its fungicidal value was not all obscured even when it was used with bordeaux.

PLATE I.—VIEW IN THE PARIS GREEN EXPERIMENT.

ROW 14, PARIS GREEN WITH BORDEAUX; 15 BORDEAUX ALONE; 16, CHECK; 17, PARIS GREEN IN WATER; 18, PARIS GREEN IN LIME WATER. Photographed September 16.

PLATE II.—VIEW IN THE ARSENITE OF LIME EXPERIMENT.

ROW 5, CHECK; 6, ARSENITE OF SODA IN LIME WATER; 7, ARSENITE OF SODA IN BORDEAUX; 8, BORDEAUX ALONE.
Photographed September 16.

Surprising differences were also shown between the rows where lime was used with the poison and where the poison was used alone, which seem unfavorable to the use of lime. These differences were constant throughout the series, but are too small to overturn previously held views without more evidence. The average yields are shown below :

YIELD BY SERIES IN THE PARIS GREEN EXPERIMENT.

Series.	Rows.	Treatment.	Yield of marketable tubers per acre.	
			Bu.	*lbs.*
I.....	1, 6 and 21.	Check ; not sprayed ; bugs hand picked.	175	—
II.....	2, 7, 17 and 22.	Paris green in water, four times.	221	9
III	3, 18 and 23.	Paris green in lime water, four times.	208	53
IV.....	4, 19 and 24.	Paris green in bordeaux four times and bordeaux alone once.	325	—
V.....	5, 20 and 25.	Bordeaux alone, five times ; bugs hand picked.	317	30

Paris green in water increased the yield **46** *bu.* **9** *lbs. per acre.*
" " " *lime water increased the yield* **33** *bu.* **53** *lbs. per acre.*
" " *with bordeaux increased the yield* **150** *bu. per acre.*
Bordeaux alone increased the yield **142** *bu.* **30** *lbs. per acre.*

Paris green in this experiment certainly was not injurious to the plants, as its use in water increased the yield 46 bu. to the acre, almost one-third as much as did the bordeaux mixture ; while its use with bordeaux increased the yield over that where bordeaux only was used, by a small, but constant quantity. The surprising feature, that the use of lime with the paris green apparently lowered the yield, may possibly be explained in this way. Though conditions of weather—rain, sunshine, etc.—appeared favorable to development of foliage-burning, none occurred ; so there was no chance for lime to exert a favorable influence ; and its presence may have interfered slightly with the fungicidal action which the experiment proves paris green to have.

While the test strengthens the view heretofore strongly advocated by this Station, that bordeaux should always be used as a

carrier for paris green on potatoes, it does not cause us to change the advice to use lime with paris green if the grower is determined to apply only the insecticide. If all conditions had been right to produce burning, it is quite certain that the use of lime would have shown a benefit.

Arsenite of lime.

A comparatively recent addition to the list of insecticides is arsenite of lime, or arsenite of soda in lime water which forms the same compound. The basis of this is white arsenic, a more soluble arsenic compound than paris green and therefore one which it would be entirely unsafe to use on foliage in its original form. But by boiling with lime, or better by boiling with soda and adding the resulting solution to lime water, an insoluble compound is formed which is cheaper than paris green, which remains in suspension better and which is a most effective insecticide.

Unless very carefully prepared, however, this arsenite of lime (or arsenite of soda) is quite liable to burn foliage. It was tested at the Station in an experiment similar to that with paris green though only four rows were necessary in each series since there could be no question about using the poison in water alone. Such treatment would mean the death of every plant sprayed.

Preparation of arsenite of lime.

Rows in each series were, in order, unsprayed, sprayed with arsenite in lime water, sprayed with arsenite in bordeaux, and sprayed with bordeaux only. The bugs on the check row and that sprayed with bordeaux only were picked by hand.

The stock solution of arsenite of lime was prepared by the Kedzie formula :

White arsenic ..... 2 pounds.
Sal soda (washing soda) ..... 8 "
Water ..... 2 gallons.

Boil 15 minutes or until the arsenic dissolves, leaving only a small quantity of muddy sediment. Replace the water lost in boiling. This makes a stock solution of arsenite of soda which may be placed in tightly stoppered jugs and kept on hand for use as needed. In preparing the spray mixture use two pounds of

freshly-slaked lime with each pint of the stock solution in the desired quantity of water or bordeaux mixture. The arsenite of soda and the lime unite to form arsenite of lime. The arsenic in one pint of the stock solution is equivalent to four ounces of paris green.

In different sprayings the quantity used varied from two to four pints in 50 gals. of liquid, and the amount of liquid from 100 to 225 gals. to the acre.

Results of test. Within a week after the first application a heavy rain fell. On the day following it was noticed that considerable burning of the foliage had occurred where the arsenite was used in lime water; but none where it was used in bordeaux. Similar injury occurred after the second and fourth sprayings; but after the third, perhaps because there was less rain, no injury was noticed. After the second spraying the injury was marked, leaves of all ages being affected with large copper-colored dead spots, some of them closely resembling the spots of late blight. A photograph of a healthy plant and one injured by the arsenite is reproduced on the title page. There was no sign of burning on the bordeaux-arsenite rows at any time. By the time of the fifth spraying the check row and that sprayed with arsenite in lime water were practically all dead, so only the bordeaux-sprayed rows were treated.

At harvest, the yields were as follows:

YIELD BY SERIES IN THE ARSENITE OF LIME EXPERIMENT.

Series.	Rows.	Treatment.	Yield of marketable tubers per acre.	
			Bu.	*lbs.*
I	1, 5, 9, 13 and 17.	Check; not sprayed; bugs hand picked.	142	25
II.....	2, 6, 10, 14 and 18.	Sprayed 4 times, arsenite of soda in lime water.	94	45
III	3, 7, 11, 15 and 19.	Sprayed 4 times with arsenite of soda in bordeaux and once with bordeaux alone.	295	45
IV.....	4, 8, 12, 16 and 20.	Sprayed 5 times with bordeaux alone; bugs hand picked.	329	45

Arsenite of soda in lime water **reduced** *the yield* **47⅔** *bu. per acre.*
Arsenite of soda with bordeaux increased " **153⅓** " " "
Bordeaux alone increased the yield **187⅓** *bu. per acre.*

From this test it is quite evident that the arsenite of soda in lime water is unsafe to use on potatoes, even when, as in the first and second sprayings, the actual amount of arsenic contained is only half as great as in the paris green which was used without harm in lime water in the other experiment.

The figures would also indicate that the arsenite is injurious, even in the bordeaux mixture; for there were more potatoes where bordeaux was used alone. But there was no evidence of foliage injury on the bordeaux-arsenite sprayed rows; so the difference in yield may have been to quite an extent accidental.

It is safe to say that whatever arsenical is used it is safest and best to apply it with bordeaux.

NOTICE CONCERNING BULLETIN No. 265.

Bulletin No. 265 is technical in character, dealing with the amount of fertilizer elements removed from the soil by one season's growth—new wood, leaves and fruit—of apple, peach, plum, pear and quince trees. No popular edition will be issued. The bulletin will be sent upon application.