

UNIVERSITY OF MISSOURI COLLEGE OF AGRICULTURE
AGRICULTURAL EXPERIMENT STATION
BULLETIN 198

SPRAYING IRISH POTATOES



COLUMBIA, MISSOURI

JANUARY, 1923

SUGGESTIONS TO POTATO GROWERS

Remember that spraying is no cure-all for the ills of the potato plant. It is merely one item in the routine of growing a good crop. Under Missouri conditions it is specifically intended for the control of "bugs" and "tipburn."

Obtain the best seed available. At present "certified seed" from the Northern States, is generally best. Such seed averaged 25 bushels per acre more than common seed in tests at this Experiment Station.

Plant as early as possible—about one month before average date of last killing frost is a good rule. At Columbia, plantings made April 1 have yielded three times as much as plantings on May 1.

Disinfect seed potatoes before cutting. Soak the seed in a solution of corrosive sublimate (Mercuric chloride—poison) for 1½ hours. Four ounces to 30 gallons of water is the proper strength. This will go far toward controlling both common and black scab. The latter disease has probably been causing great loss in Missouri for years. In 1922, some Missouri fields were found where 40 percent of the plants were affected so that few potatoes could be formed.

Do not attempt to grow potatoes on poor land without manure or fertilizer. Rotted stable manure will generally increase yields. The general use of commercial fertilizer is also recommended—the 2-12-2 and 2-10-4 formulas being well suited for the potato crop on many soils. Apply the fertilizer in the row before planting, at the rate of 400 pounds per acre.

Spray the potato plants—not only for control of insects but for prevention of tipburn or hopperburn. Standard 4-4-50 bordeaux mixture and arsenate of lead is the proper combination. Spray four or five times, and cover all parts of plants.

Under Missouri conditions spraying is more likely to give desirable results with the Irish Cobbler variety, because the tubers of this variety are not subject to second growth. It is doubtful if spraying with bordeaux mixture will give pleasing results on varieties of the Early Ohio type, because of their tendency to make misshapen tubers as a result of second growth when the plants are kept alive in midsummer by spraying.

SPRAYING IRISH POTATOES

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Although spraying the Irish potato crop with bordeaux mixture is regularly practiced by the best growers in most of the leading potato districts of the country, this treatment has not yet become general in Missouri. This probably has been due to the fact that the diseases for which bordeaux mixture was formerly recommended—early blight and late blight—do not commonly occur on potato plants in Missouri in spring and early summer. In other states long continued experiments have shown that proper spraying with bordeaux mixture generally increases potato yields even in seasons when these diseases are absent. The purpose of the present bulletin is to call the attention of Missouri potato growers to the desirability of spraying potatoes, not only with an arsenical to kill insects, but with bordeaux mixture as well. Two years' experiments at Columbia have indicated beneficial action from such sprays, not in the control of any disease in the commonly accepted meaning of that word, but in the prevention of the conditions known as "tipburn" and more recently as "hopper-burn."

CONDITIONS OF THESE TESTS

The spraying experiments were conducted at Columbia, Missouri, on Putnam silt loam soil, which is naturally of rather low productivity. The plots were all fertilized alike, with 400 pounds of commercial fertilizer (2-12-2 formula) drilled in the row before planting. The rows were 3½ feet apart and the plants were spaced exactly 15 inches apart in the rows. Good strong healthy strains of northern-grown seed potatoes were used both years. There were practically no plants infected with mosaic or leaf-roll in any of the plots. The applications of spray materials were made with a hand power sprayer of the wheelbarrow type. Especial care was taken to see that all parts of the plant were covered with the spray, including both upper and lower surfaces of the leaves. It should be said that this very careful covering of all surfaces of the plant with spray material, even with a low pressure outfit, might be expected to give better results than rather careless application on a large scale with a power sprayer.

RESULTS IN 1921

Only the Early Ohio variety was used this year. Planted March 20, the plants were up April 25 and the first application of sprays made May 20. Four applications were made, about 10 to 14 days apart, the last spraying being made July 5. At the time of the last spray the plants in the check or unsprayed plots were showing considerable "tipburn" or "hopper-burn" and a few days later these plants were practically dead. The plants sprayed with arsenate of lead alone were about the same as the checks. However, the plants sprayed with bordeaux mixture remained quite green until early in August. Early in July a striking difference was noted between

the condition of the lower and older leaves on the sprayed and unsprayed plants.

These leaves, which are formed early in the season, are much larger and smoother than those formed later, during hot weather. On the unsprayed plants, these lower leaves began burning and curling around the margins about July 1, thus giving the plant a false appearance of approaching maturity. On the sprayed plants, these leaves remained intact for at least a month longer. Examination about July 1 showed great numbers of small green insects—leafhoppers—on the unsprayed plants. There were only a few of these insects on the bordeaux-sprayed plants until after the middle of July. At that time, all the unsprayed plants being dead and spraying having been discontinued on the sprayed plots, the number of leafhoppers on the sprayed plants gradually increased until these also were killed.

All the plots were dug August 29, and at that time all the plants were dead. The results are given in Table 1.

TABLE 1.—SPRAYING EXPERIMENTS IN 1921, WITH EARLY OHIO VARIETY ONLY.

Spray used	Yield, bu. per acre	Gain from spraying	
		Bu. per acre	Percent gain
None	113.0		
Lead arsenate alone	127.5	14.5	12.8
Bordeaux mixture alone	152.5	39.5	35.0
Bordeaux mixture and lead arsenate	165.3	52.3	46.3
Bordeaux mixture, plus lead arsenate, plus nicotine sulphate	168.0	55.0	48.7
Pyrox	166.6	53.6	47.4

Though no biting insects, as Colorado beetles and flea beetles were present on any of the plants during the period of the spraying experiment, still there was a slight gain in yield on the plot sprayed with lead arsenate. The principal result of the spray tests, however, was a very marked increase in yield on the plots sprayed with bordeaux mixture alone and in different combinations. So far as appearance of the plants is concerned, there was little difference between the last four plots. The results indicate that bordeaux mixture in combination with lead arsenate is more effective than bordeaux mixture alone, even when biting insects are absent. There appears to be no necessity for adding nicotine sulphate to the spray material, which is interesting, in view of the fact that the leafhopper is a sucking insect. Spraying tests in other states recently have shown similar results.

An examination of the potatoes produced in the different plots showed that the tubers from the sprayed plots consisted largely of knobby second growths so that the actual quantity of marketable potatoes from the sprayed plots was really much less than from the check plots, the tubers of which showed second growth only to a moderate extent.

The Early Ohio variety, which is the leading variety at present in

the lower Corn Belt, seems much more subject to second growths of the tubers than other varieties grown at Columbia the past four years. During the growing season of the last year, the weather consisted of short, wet periods alternating with longer hot dry spells. The result, of course, was a sharp variation in soil moisture in the potato field. Such fluctuations of soil moisture are probably the immediate cause of the second growths on the tubers, especially on those from the sprayed plots which continued to grow vigorously even when moisture fluctuations were sharpest.

Furthermore, since Duggar and Bonns* have shown that a film of bor-



Fig. 1.—Two rows on left not sprayed—on right sprayed four times with bordeaux mixture and arsenate of lead.

deaux spray on the leaves of the potato plant increases the transpiration rate, it may be supposed that the water deficit is the greater in sprayed plants in the field during dry periods. This point appears all the more probable when one considers the larger expanse of leaf surface possessed by the sprayed plants. Presumably, tuber growth ceases when lack of moisture makes conditions unfavorable for the development of the plant as a whole. When rain comes, growth again proceeds vigorously for a few days. The tuber development resulting from such spurts of growth, in the case of the Early Ohio variety, seems to be laid down mostly in knobby protuberances from the eyes, especially at the tips of tubers previously

*Annals Mo. Bot. Garden, 5: 153-176, April 1918.

formed. As many as four or five distinct growth zones could be identified on some of the knobby tubers from the sprayed plots. It seems, therefore, that we have here a serious objection to spraying varieties like Early Ohio with bordeaux mixture.

SPRAYING EXPERIMENTS IN 1922

This year both the Early Ohio and the Irish Cobbler varieties were used in the spraying experiments. Also the test plots of each variety were in duplicate though only the average yields of these duplicate plots are given in Table 2.

TABLE 2.—SPRAYING EXPERIMENTS IN 1922, WITH IRISH COBBLER AND EARLY OHIO.

Treatment	Yield	Gain from spraying	
	Bu. per acre	Bu. per acre	Percent gain
IRISH COBBLER			
No spray	82.5		
Lead arsenate alone	100.0	17.5	21.2
Bordeaux mixture plus lead arsenate	184.5	102.0	123.6
Bordeaux mixture plus lead arsenate, plus nicotine sulfate	177.8	95.3	115.5
Copper sulphate $\frac{1}{2}$ pound to 50 galls.	108.7	26.2	31.8
EARLY OHIO			
No spray	120.3		
Lead arsenate alone	126.6	6.3	5.2
Bordeaux mixture plus lead arsenate	195.7	75.4	62.6
Bordeaux mixture plus lead arsenate, plus nicotine sulfate	192.9	72.6	60.3
Copper sulphate $\frac{1}{2}$ pound to 50 galls.	133.6	13.3	11.6

Planted April 24, the plants were up May 15 and the first application of spray was made June 9. Four applications of all the different sprays were made, the last application being made July 20. Few Colorado potato beetles or flea beetles were present at any time on any of the plants, but leafhoppers became abundant the last of June, and severe burning of the leaves appeared early in July on unsprayed plants of both varieties. The plants sprayed with bordeaux mixture continued green and fairly free from burning until August, in fact these plants were quite green when the plots were harvested August 14. The plants sprayed with arsenate of lead alone died soon after the unsprayed checks. The plants sprayed with the weak copper sulphate solution remained green somewhat longer than the checks. This weak copper sulphate spray, which has been called the "water cure" seems to have some value. If it were combined with lead arsenate, or if a slightly stronger solution was used, it might have been more effective.

The increases in yield as a result of spraying with bordeaux mixture in combination with arsenate of lead were greater on the Early Ohio variety in 1922 than the previous year. The increase in yield as a result of spraying was even greater in the Irish Cobbler variety than in the Early Ohio variety.

Examination of the tubers from the bordeaux-sprayed plots of the Early Ohio showed the same condition as the previous year, the majority of the tubers being misshapen as a result of second growth, or bearing knobby protuberances. The Irish Cobbler tubers, however, in the sprayed plots were practically free from second growth. The tubers were not misshapen nor knobby to any great extent. This is a result of very great importance to the potato growers of the State. It seems that spraying of the Early Ohio variety with bordeaux mixture is not likely to pay in spite of the increased yield, because of the tendency of the tubers of this variety

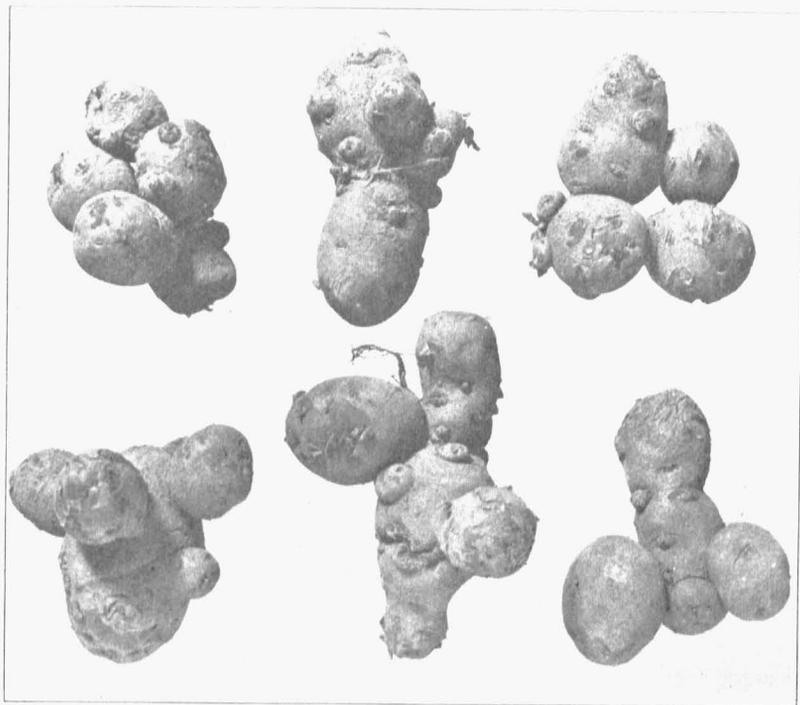


Fig. 2.—Tubers produced on plants of the Early Ohio variety which were kept green during midsummer by spraying with bordeaux mixture.

to develop into knobby, unmarketable second growth shapes when the plants are kept alive during the summer by means of spraying. Under average Missouri conditions, however, it seems equally certain that spraying of potatoes of the Irish Cobbler variety will pay well, because of the large increase in yield resulting and because practically all the tubers from sprayed plants of this variety are of marketable shape.

It should be said here, however, that the grower who intends to dig his potato crop comparatively early in the summer for sale on the early market, is not likely to gain very much by spraying with bordeaux mixture. If dug at the time the unsprayed plants are beginning to die, which is

usually early in July, it is probable that both sprayed and unsprayed plants would yield about alike. In other words, the increased yield of tubers obtained in these spraying experiments is probably due almost entirely to tuber growth made by the sprayed plants after the unsprayed plants have begun to die. Spraying them is simply a means of keeping the plant alive and functioning for a longer period, thereby permitting greater opportunity for tuber development, which results in a considerable increase in yield if the crop is dug comparatively late, as during August.

DIRECTIONS FOR SPRAYING

For the small garden plot, and for patches of an acre or less such as would be grown by the average farmer, the wheelbarrow type of sprayer will prove practical. A barrel pump mounted in a wagon, will also prove useful, if the rows are so spaced that the wagon-tread matches the row middles. For larger areas of commercial scope, a traction power sprayer is most desirable. Sprayers of this type should be equipped with a boom so that three or four rows can be sprayed at a time. The ideal arrangement is to have three spray nozzles for each row. (See picture on cover page.) To cover the plants thoroughly with the spray material one nozzle should be directed at the plants from each side and one from above. When the plants are very large, all surfaces of the plant can be thoroughly covered only by going over the field twice—and from opposite directions. This, of course requires a larger amount of spray material, but is necessary for effectiveness.

Method of Preparing Standard Bordeaux Mixture.—At the beginning of the season stock solutions are prepared as follows: 50 pounds of copper sulphate (bluestone or blue vitriol) are dissolved in a barrel containing 50 gallons of water. Likewise 50 pounds of fresh burned lime are slaked in another barrel and made up to 50 gallons. Whenever a given quantity, say 50 gallons, of 4-4-50 bordeaux mixture is desired, 4 gallons of the copper sulphate stock solution are measured out and added to 21 gallons of water in another barrel. Likewise 4 gallons of the lime are measured out (after stirring up) and added to 21 gallons of water in another barrel. The dilute lime and copper solutions may then be mixed by pouring together simultaneously, or by pouring the lime into the copper. This final mixing, which gives the bordeaux mixture, is usually done in the tank of the spraying machine. When spraying potatoes, $1\frac{1}{2}$ pounds of dry form of arsenate of lead should be added for each 50 gallons of bordeaux mixture.

Time of Application.—The first spraying for potatoes should be given when the plants range from 4 to 6 inches in height. The bordeaux mixture and lead arsenate combination applied at this time is effective in repelling the flea beetles, small black insects which do considerable damage by puncturing the leaves early in the season, though this insect is very frequently overlooked. Thereafter, the potato plants should be sprayed every 10 or 14 days, depending on the weather and the rate of growth of the plants. The new foliage must be covered with spray material as the plant grows. Usually four or five applications during the growing season will be sufficient.