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POTATO SPRAYING

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POTATO SPRAYING

The spraying of late potatoes with Bordeaux mixture has become a recognized necessity in Connecticut if profitable yields are to be obtained. With early potatoes, although spraying for disease is usually not necessary, preventive treatment against flea beetles has been found desirable for best results.

Earlier experiments¹ conducted by this Station from 1902 to 1914 showed an average increase in yield of 38 bushels per acre by spraying with 4-4-50 Bordeaux mixture. The average yield from unsprayed plants during this 13-year period was 115 bushels per acre; therefore spraying increased the yield by 33 per cent. During certain years, when late blight was prevalent, the yield was increased by 100 bushels of potatoes per acre. Recently, further experiments have been conducted at the Experimental Farm, Mount Carmel, which show much larger crop gains in blight-free years than those previously recorded. At the same time additional data have been collected in regard to strength of spray, optimum pressure for spraying, and insect control.

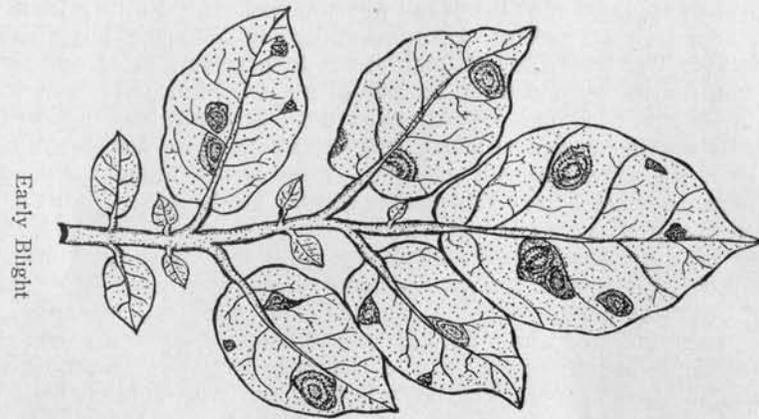
Foliage Diseases of the Potato

Spraying with Bordeaux mixture prevents two important diseases of potatoes, the early and late blights. Late blight, *Phytophthora infestans*, is by far the more serious of the two. Sometimes this disease appears early in July and in periods of wet weather it may spread rapidly over an entire field. It begins as large, watersoaked leaf-spots on the under surfaces of which a fine, whitish mildew may frequently be seen. The fungus may finally destroy the foliage entirely leaving the potato plants blackened and wilted. When the tops are blighted, tuber infection usually follows. This in turn results in a rot of the potatoes with serious losses in crop yield.

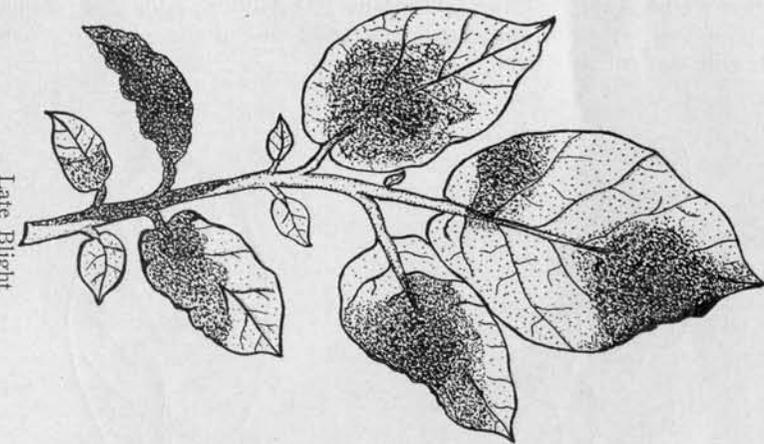
The injury caused by early blight, *Alternaria solani*, is less extensive than that by late blight. This fungus is confined to irregular brown spots marked with concentric rings on the leaves, which diminish the amount of healthy leaf surface. If the blight becomes serious some defoliation may take place. In Connecticut early blight is usually present every year whereas late blight is prevalent only during bad blight years after extended periods of rainy or foggy weather.

Potato Insects

The potato flea-beetle, *Epitrix cucumeris*, is a black, jumping insect about one-sixteenth of an inch long, which chews small, round holes in the leaves. There is one generation a year in Connecticut. The adult emerges from hibernation and attacks potato plants soon after they appear above ground. Eggs are deposited during the latter part of May and throughout June. The larvae feed on potato roots and tubers and emerge as adults in July and August.



Early Blight



Late Blight



Tipburn

FIGURE 31. Leaf Diseases of Potatoes

¹Conn. Agr. Expt. Sta., Rept. of the Station Botanist, pp. 471-487. 1915.

Thorough application of Bordeaux mixture reduces the injury from this insect, acting as a repellent. Bordeaux does not actually kill many of the beetles. On Irish Cobbler potatoes a dust, composed of one pound of barium fluosilicate and three pounds of hydrated lime, has been found to be more effective than Bordeaux mixture in controlling flea-beetles. This dust should be applied about June 1 and June 10, and again about July 10 if the vines are still growing. With Green Mountain potatoes our comparative tests have shown that greater yields result from the use of Bordeaux mixture. For maximum return the plants should be kept covered with Bordeaux, especially during July and August, in order to insure protection against serious flea-beetle damage.

The Colorado potato beetle, *Leptinotarsa decemlineata*, feeds on the leaves of the potato plant. Both larvae and adults cause damage. The adult beetle is about three-eighths of an inch long and is yellow with longitudinal black stripes. The larva is dark red with a black head and two rows of black spots on each side of the abdomen. It is about one-sixteenth of an inch long when newly hatched, and grows to a length of one-half inch. Lead arsenate, or calcium arsenate added to Bordeaux mixture at the rate of three pounds to 100 gallons, or a dust containing one pound of either of the above arsenates and nine pounds of hydrated lime, will control this pest.

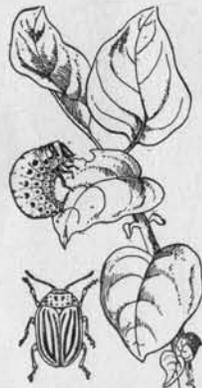


FIGURE 32.
Colorado Potato Beetle



FIGURE 33.
Potato Leafhopper

The potato leafhopper, *Empoasca fabae*, is a sucking insect, pale green in color, with transparent wings, and is about three-sixteenths of an inch long. The nymphs are wingless, pale green, and are smaller than the adults. These insects suck the sap from the leaves and cause serious injury to the foliage, known as *hopper-burn*. The injury usually occurs on late potatoes during August and September and reduces the yield considerably. Thorough applications of Bordeaux mixture kill the leafhoppers.

The potato aphid, *Macrosiphum solanifolii*, occasionally does great harm to the potato crop by sucking sap from the leaves and terminal shoots.

This insect does not cause serious damage every year, but occasionally there is a severe outbreak. A thorough application of 4 per cent nicotine dust, applied under a canvas dragged behind the duster, usually controls these plant lice. The dusting should be done on a hot day. The addition of one part of 40 per cent nicotine sulfate solution to 800 parts of the regular Bordeaux spray is also effective in controlling potato aphids.



FIGURE 34.
Potato Aphid



FIGURE 35.
Potato Flea Beetle

Tip-burn of Potato

The application of Bordeaux mixture to potatoes has other desirable effects, at least in the region of Connecticut, besides combatting the above mentioned diseases and insects. During certain dry years tip-burn of potatoes, which is frequently mistaken for late blight, has resulted in serious losses in this state. There are apparently two types of tip-burn of the leaves. One, recognized by a browning of the leaf margin and upward rolling of the leaf edge, is believed to be caused by bright sunlight and lack of soil moisture. The other is an injury caused by the feeding punctures of the leafhopper, and is usually noticeable at the ends of the larger veins of the leaf. Prevention of these tip-burns and the additional protection against unfavorable conditions of climate afforded by Bordeaux mixture, together with its possible stimulative effect upon the growth of the potato plant, combine to extend the growing period and consequently increase yields.

Time and Frequency of Sprays

In order to prevent excessive damage by the flea beetle, it is well to begin spraying potatoes soon after the plants appear above ground. In our experiments with late potatoes, planted May 15, good results have been obtained by commencing to spray with Bordeaux mixture about the first of July. Earlier plantings might require somewhat earlier spraying. By making successive applications of Bordeaux every week or ten days, the potato foliage may be maintained in a healthy, active condition until the growing season is over and thus larger yields obtained. We have found that a smaller number of sprays per season are necessary when the work is done thoroughly, and that 8-8-50 Bordeaux mixture lasts longer on the plants than 4-4-50 mixture. An experiment conducted in 1932 showed that plants sprayed only four times with 8-8-50 Bordeaux

yielded 29 bushels of potatoes per acre more than others sprayed seven times with the 4-4-50 mixture. Under normal conditions, from six to ten applications of spray should be made per season, depending upon the growth of the plants, weather conditions, and thoroughness of spraying.

Pressure, Amount of Spray, Concentration and Coverage

Our experiments seem to show that the best coverage has been obtained by the use of a double strength spray, applied at a fairly high pressure (350 to 400 pounds per square inch) and at a rate of 200 or more gallons per acre. Smaller amounts are used in spraying younger plants. This treatment has been found to require the least number of applications in order to maintain good coverage throughout the season.

Complete coverage of the plant with Bordeaux mixture is the important, desirable aim in potato spraying. It seems that the means of securing this coverage are less important than the complete coverage itself. Our experiments have shown an average difference in yield of 18 bushels per acre between plots sprayed at a pressure of 400 pounds per square inch and plots sprayed at 200 pounds when 4-4-50 Bordeaux mixture was used. With 8-8-50 Bordeaux, this difference between low and high spraying pressures has amounted to only 10 bushels per acre. However, greater care and more time were necessary in securing good coverage with the lower than with the higher pressure. Likewise, four spray-nozzles to the row and larger amounts of spray material secured more thorough coverage by reaching all of the foliage.

Results of Recent Experiments at this Station

The results of experiments conducted with late potatoes at Mount Carmel, over a three-year period from 1931 to 1933, have shown Bordeaux mixture to produce profitable increases in yield each year. The 8-8-50 Bordeaux (8 pounds of copper sulfate, 8 pounds of hydrated lime and 50 gallons of water) increased the yields more than the weaker 4-4-50 mixture.

Year	Yield—Bushels Marketable Tubers per Acre			
	Check (untreated)	Copper lime dust	Bordeaux mixture	
			4-4-50	8-8-50
1931	225	279	318	343
1932	113	235	219	295
1933	74	99	165	257
Average	137	204	234	298

We have been unable to secure consistent increases in the yield of potatoes by use of copper-lime dust. In 1932 this dust, applied twice as frequently as the spray applications, produced yields which were only comparable with the poorest ones obtained from the regular applications of 4-4-50 Bordeaux mixture. The data upon yields from the use of the stronger and weaker spray mixtures and also from the use of copper-lime dust are shown in the table above.

Tubers from the plants sprayed with Bordeaux mixture were much larger than those from the unsprayed or dusted plots, as is shown by the following numbers of tubers necessary to make 100 pounds in weight: untreated, 342; copper-lime dust, 345; 4-4-50 Bordeaux, 250; 8-8-50 Bordeaux, 246.

In 1933, one field of potatoes containing both Irish Cobbler and Green Mountain varieties, on land different from that used in the above experiments, was sprayed with 6-6-50 Bordeaux mixture. Here the early variety in unsprayed plots produced 128 bushels per acre while the sprayed plants produced 252 bushels. With the late variety, the spray treatment increased the yield from 196 to 457 bushels per acre. In the latter case, the percentage increase of the 6-6-50 spray treatment will be found to be intermediate between the 4-4-50 and 8-8-50 results recorded in the above table for this year.

Tests were made in 1931 with a 12-12-50 Bordeaux mixture, but the yield with this spray was only six bushels per acre more than that with the 8-8-50 Bordeaux.

At Windsor, an experiment carried out in 1933 with late potatoes on land previously planted with tobacco gave results similar to those obtained at Mount Carmel. The yields of potatoes from this plot, showing the variations between the different spraying and dusting treatments, are listed in the following table. In this experiment the lead arsenate and fish oil spray, and the barium fluosilicate dust, both gave good control of the potato flea beetles. Therefore, the increases in yield of 40 and 51 bushels of first grade potatoes per acre respectively for these two

Treatment	Yield—Bushels per acre		
	Firsts	Seconds	Increase over untreated
			Firsts
Untreated	176	23	
Lead arsenate fish oil spray	216	13	40
Copper-lime dust	225	16	49
Barium fluosilicate dust	227	16	51
4-4-50 Bordeaux spray	376	12	200
8-8-50 Bordeaux spray	404	7	228

treatments probably show the approximate amount of damage caused by the flea beetle. The much larger increases in yield obtained by the Bordeaux sprays show the greater amount of benefit resulting from the additional control of leafhoppers and diseases, and the general beneficial effects of the Bordeaux mixture.

Preparation of Bordeaux Mixture

Bordeaux mixture is prepared by mixing solutions of lime and copper sulfate. Freshly slaked stone lime is probably the best for this purpose. Fresh hydrated lime is entirely satisfactory, however, and is widely

used because of its convenience. Hydrated lime for Bordeaux mixture must be fresh, very fine and of high quality. The ordinary crystalline copper sulfate, (bluestone or blue vitriol), is usually used in preparing Bordeaux mixture. Monohydrated copper sulfate, (copper snow), has been advocated. It dissolves more quickly, but it is too expensive for general use. Ordinary copper sulfate can be dissolved in cold water in about two hours by placing the required amount in a burlap bag and hanging it just in contact with the surface of the water in a wooden tank or barrel. The combined action of the air and water acting simultaneously on the copper sulfate crystals makes them pass into solution readily.

In making Bordeaux mixture, the two dilute materials may be mixed in the spray tank, or one of these materials may be diluted in the tank and the other ingredient added in a concentrated solution, with the agitator in operation. Strong agitation during the mixing process aids in making a better Bordeaux mixture. Laboratory tests have shown that addition of concentrated copper sulfate (1 pound in 1 gallon of water) to diluted lime (1 pound in 6 to 12 gallons of water) produces a Bordeaux mixture which stays in suspension longer than that produced by other methods. However, this method is only slightly superior to that of adding dilute lime (1 pound in 3 to 6 gallons of water) to dilute copper sulfate (1 pound in 3 to 6 gallons of water).

The use of 4-4-50 Bordeaux mixture has been found to produce satisfactory yields of potatoes. However, in our experiments, 6-6-50 and 8-8-50 Bordeaux have always increased the yields more than enough to pay for the additional amounts of materials necessary to strengthen the spray solution.