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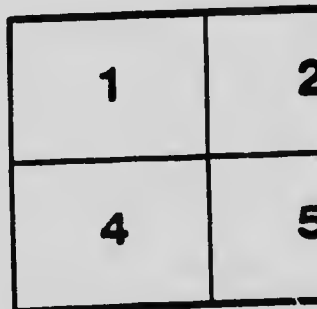
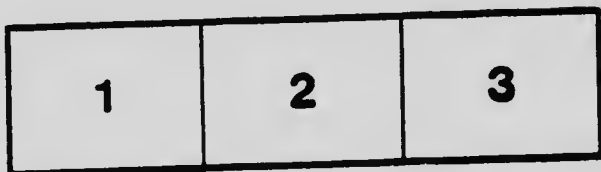
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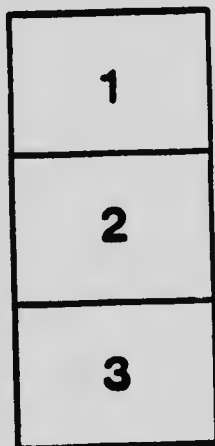
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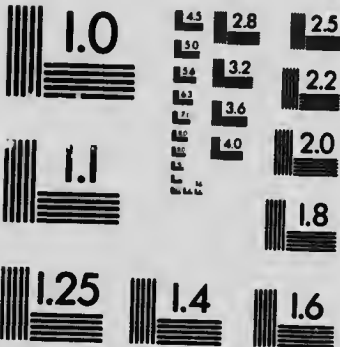
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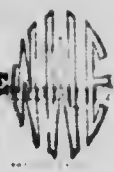
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ENTOMOLOGICAL BRANCH.

C. GORDON HEWITT, DOMINION ENTOMOLOGIST.



*Crop Protection Leaflet No. 10.*

# ARSENATE OF LIME.

*(Calcium Arsenate).*

During the last few years the Entomological Branch has been devoting increased attention to the study of insecticide, with special reference to the possibility of securing cheaper materials. One of the first results of this study consisted in a demonstration of the value of arsenate of lime or calcium arsenate as an insecticide. On account of the low cost as compared with the cost of other widely used insecticides, its use is highly desirable for many purposes at the present time. Its value has also been recognized for the same reason in the United States.

At the present time arsenate of lime, which should be clearly distinguished from arsenite of lime, is only recommended as a spray for apple, potato and pear; it is not regarded as a safe insecticide for trees having tender foliage such as plum, cherry or peach. Nor do we recommend the use of arsenate of lime alone, but only in conjunction with lime, Bordeaux mixture, or sulphide sprays as described later. During the years 1915, 1916 and 1917 it has been used in Nova Scotia both commercially and experimentally in a variety of ways. Although the results from its use have not been uniformly satisfactory, this could not be expected on account of the lack of knowledge concerning the material. Nevertheless the satisfaction following its use has been such that orders for arsenate of lime in Nova Scotia in 1918 have exceeded those of all previous years combined; in fact, the orders for arsenate of lime in the Annapolis Valley exceed those for all other arsenical insecticides combined.

In discussing this poison it must be understood that unless otherwise stated we refer to the commercial dry material containing 40 per cent arsenic oxide in the form of tri-calcium arsenate and less than 1 per cent soluble arsenic, and so powdered that one pound of the dry material occupies eighty cubic inches. Although originally intended for use with Bordeaux mixture it was soon found, after the material had been introduced, to be the only poison that could be used safely with sulphide sprays, that is without being responsible for unsatisfactory results such as injury to foliage or the formation of undesirable chemical combinations.

### *The action of Arsenate of Lime on foliage when used alone.*

Many growers and investigators have used arsenate of lime alone, usually with disastrous results. The properties of this material are such that, when it is used alone, it causes a yellowing and often a burning of the foliage. The yellowing is generally caused by the formation of soluble arsenical compounds, and burning results from either an excessive use of the insecticide or certain weather conditions which abnormally hasten the breaking up of the material and the liberation of soluble arsenical compounds. Injury from the use of arsenate of lead alone is usually slight at first,

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increasing with each successive day for a week or more. The use of arsenate of lime alone on foliage is not recommended, although it has been used in some cases successfully on potatoes.

Used in conjunction with lime no damage such as burning of the foliage need be apprehended.

#### *The use of Arsenate of Lime with Lime.*

It has been found that where ten parts of either water-slaked or hydrated lime is used to one part of arsenate of lime, the material can be applied to apple and potato foliage without injury.

#### *Arsenate of Lime compared with Arsenate of Lead when used with Lime-sulphur.*

The following comparisons of arsenate of lime and arsenate of lead with lime-sulphur may be drawn from three years experience with arsenate of lime in Nova Scotia: Arsenate of lime with lime-sulphur has invariably given slightly better results in the control of fungous diseases than arsenate of lead with lime-sulphur. This is very possibly due to the fact that upwards of 35 per cent of the sulphur may be precipitated in the latter composition. Arsenate of lime with lime-sulphur has, in all experiments in Nova Scotia, caused less leaf-burning or singeing than the arsenate of lead with lime-sulphur spray. This is on account of the larger quantity of soluble arsenic in the latter combination.

Arsenate of lime with lime-sulphur has caused noticeable yellowing of the leaves more often than the arsenate of lead with lime-sulphur combination. The underlying causes of the yellowing of the leaves would appear to vary and they are now being investigated. It may be noted, however, that only here and there an isolated grower reported yellowing from the third spray (that applied immediately after the blossoms), while possibly 5 per cent of those who used lime-sulphur with arsenate of lime for the fourth spray (the spray applied two weeks after the blossoms) reported yellowing.

The type of yellowing that is due to arsenical injury can be easily eliminated by adding either five pounds of water-slaked or hydrated lime to each 40 gallons of the lime-sulphur with arsenate of lime combination when used for the sprays after the blossoms. So far as our observations go, the addition of lime to the third spray (the spray immediately after the blossoms) is only necessary in orchards where the trees are subject to yellowing on account of the variety of apple or the treatment of the orchard. Lime sulphur is not advocated by us for the spray two weeks after the blossoms, but where it is used as a fungicide in that spray and arsenate of lime is added for a poison, it would seem advisable to add five pounds of water-slaked or hydrated lime to prevent the liberation of soluble arsenic and the yellowing of the leaves.

The trees sprayed with the arsenate of lime with lime-sulphur combination have in all the experiments carried on by us for three years given more apples than those sprayed with the lime-sulphur and arsenate of lead combination.

In poisoning value arsenic in the form of arsenate of lime (with lime sulphur) is fully equivalent to an equal quantity of arsenic in the form of arsenate of lead.

The arsenate of lime with lime-sulphur combination is much more easily and thoroughly agitated than the arsenate of lead with lime sulphur combination on account of its physical properties and freedom from lead sulphide or "sludge."

Arsenate of lime in its convenient powdered form may be more easily and accurately weighed and added to the spray, and it may also be stored more safely than paste arsenate of lead.

Arsenic in the form of arsenate of lime is less than 60 per cent of the price of arsenate of lead in the paste form according to the prices in Nova Scotia for 1918.



*The use of Arsenate of Lime with Sulphide Sprays.*

Arsenate of lime is the only poison on the market that can be used with sulphide sprays, such as lime sulphur, barium tetra-sulphide and sodium sulphides, such as "Soluble Sulphur" and "Sulfocide," without such chemical change taking place between the sulphide and the poison as would result in injury to foliage. When acid (hydrogen) or standard lead arsenite is added to lime-sulphur a certain amount of double decomposition occurs resulting in the formation of lead sulphide and crude arsenite of lime, five per cent of which is soluble arsenic. This reaction may precipitate as much as 35 per cent of the sulphur from the solution as lead sulphide, the black "sludge" with which the orchardist is familiar. Arsenate of lime, on the other hand, does not cause any perceptible decomposition or change in the sulphide composition and the standard brands contain much less than one per cent of soluble arsenic. The presence of lime sulphur in the spray prevents the formation of soluble arsenic compounds from arsenate of lime.

With sodium sulphide solutions, such as "Soluble Sulphur" and "Sulfocide," arsenate of lime is the only commercial poison that can be used without damage to foliage resulting from the formation of soluble arsenical compounds.

On account of the apparent increase in the toxic value of arsenicals that results from the presence of sodium salts, it has been found desirable to decrease the amount of arsenite of lime used with sulphide sprays to the proportion of one-half pound of arsenate of lime to forty gallons. It has been found that the sodium sulphide solutions do not adequately protect the arsenite of lime against air and that in order to eliminate yellowing where the sodium sulphide with arsenate of lime combination is used for the four sprays, 10 pounds of hydrated or water-slaked lime must be added to each 40 gallons, although it may be pointed out that injury has been practically eliminated by using five pounds of lime to each 40 gallons in an orchard that was not well-cared for.

*The use of Arsenate of Lime with Bordeaux Mixture.*

Arsenate of lime has given the best of satisfaction and no leaf injury when used as a spray for the apple in conjunction with Bordeaux mixture made according to the various formulæ. It would appear that on account of its adhesive qualities arsenate of lead assists the fungicidal action of Bordeaux mixture more than arsenate of lime. On the other hand, the difference in cost and greater convenience are both in favour of arsenate of lime.

*Formulæ for use of Arsenate of Lime.*

As a potato spray:—

Arsenate of lime: 1½ pounds,  
Bordeaux mixture: 40 gallons.

As an apple spray: The following proportions are practically equivalent on account of the effect of the fungicides on the action of the poisons:—

With Bordeaux mixture: 1 pound of arsenate of lime to 40 gallons,  
With lime sulphur: ¾ pound of arsenate of lime to 40 gallons, adding 5 pounds of hydrated or water-slaked lime to the two sprays applied after the blossoms.

With "Soluble Sulphur" and "Sulfocide": ½ pound of arsenate of lime to 40 gallons, adding 10 pounds of hydrated or water-slaked lime to each spray.

*Cost of Arsenate of Lime Compared with other Poisons.*

When the cost of arsenic is taken into consideration arsenate of soda is the only arsenical insecticide that approaches in any degree arsenate of lime in cost as a potato poison. Paris green and arsenate of lead are at the present time costing about two-thirds more than arsenate of lime while arsenite of zinc is costing about one-third more.

*Manufacture of Arsenate of Lime.*

Arsenate of lime when it is to be used with Bordeaux mixture may be manufactured at home by dissolving nine-tenths of a pound of arsenate of soda (65 per cent arsenic oxide) in water and using all the solution, which would be about two quarts, to slake enough lime for forty gallons of Bordeaux mixture. Whether this material has any advantages over that made by adding the arsenate of soda solution to the completed Bordeaux mixture is questionable.

The home manufacture of arsenate of lime for use with sulphide sprays is not advised at the present time as the difference in cost between the home and factory made material is usually slight and is not always in favour of the home-made.

A first-class arsenate of lime is rather a hard material to make, even in a well equipped laboratory or factory, as is shown by the fact that there are now on the market some brands of arsenate of lime that are very low in arsenic, are coarse and gritty and in which the percentage of soluble arsenic is too high for safety when used with sulphide sprays. These materials are being sold for only a few cents less than well-manufactured articles containing twice the amount of arsenic. It is feared that all makes of arsenate of lime will suffer from the trouble that must follow the use of this material when combined with other sprays than Bordeaux mixture.

We have used and found satisfactory arsenate of lime manufactured by the following firms:—

- The Sherwin-Williams Co., Montreal, Can.
- The Canada Paint Co., Montreal, Can.
- The Canada Rex Spray Co., Brighton, Ont.
- The Riches-Piper Co., New York, U.S.A.
- The General Chemical Co., New York, U.S.A.

Buyers, in order to protect themselves, can ask a guarantee of less than one per cent of water soluble arsenic in addition to a guarantee of the arsenic content and the form of the arsenic content, which should be tri-calcium arsenate. Also, if they desire a guarantee of fineness, they may stipulate that one pound of arsenate of lime shall occupy not less than 70 to 90 cubic inches of space. We would advise buyers to be most careful in ordering arsenate of lime for use with sulphide solutions. And again we would impress upon growers the fact that it is important to distinguish between arsenate of lime or calcium arsenate, to which material this circular refers, and arsenite of lime or calcium arsenite which is a different material requiring further investigation.

We shall be pleased to hear from any one concerning damage or trouble of any kind due to insect pests. No postage is required on such letters of inquiry when addressed:—

DOMINION ENTOMOLOGIST,  
Department of Agriculture,  
OTTAWA, ONT

Such inquiries should be accompanied in all cases where it is possible by specimens of the insects. The insect should be sent packed with their food plant in a strong wooden or tin box to prevent loss in transit. Packages up to 12 ounces in weight may be mailed free and every package should bear or contain the sender's name and address and be accompanied by a letter.





