THE DEVELOPMENT OF IMPROVED DUSTING MACHINES AND DUSTING MATERIALS

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Spraying
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by

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THESIS

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To obtain a clear understanding of the problems met with and the difficulties overcome in developing improved dusting machines and materials for the control of orchard pests and diseases by the application of insecticides and fungicides in the form of dry powders, a brief review of the history of dusting up to 1914 seems necessary.

For considerable length of time, the grape growers of France, Spain and Italy had been utilizing the dusting method for the protection of their vineyards against insects and diseases. The method of application of the materials, which was called "sulphuring" was very crude and therefore not entirely efficient.

In the southern part of our country, dusting had been in vogue for a considerable period, as a means of applying poisons such as Paris Green, London Purple, etc., to tobacco, cotton and similar crops. Here, the application of the dust was usually accomplished by the "bag and pole" method which consisted of shaking a pole carried between two horsemen riding opposite each other, so that the material, by the shaking action, would be sifted through the muslin sacks or bags which were hung to the pole directly over the rows.

Orchard dusting had been in limited use and had been the subject of considerable amount of experimental work during a period of at least twenty years. The machinery used was either hand operated of of a very crude mechanical

type securing its power from a small gasoline engine.

About 1910, much enthusiasm was manifested over experiments conducted in Illinois and elsewhere with a crude powdered form of Bordeaux Mixture, Bordeaux at this time being widely used as a liquid spray. On account of inadequacy of the machinery for making the applications, and the crudeness of the dusting materials used, these very promising experiments soon lost favor and the wave of dusting enthusiasm soon died out.

In 1914 and 1915, the writer was closely associated with the Cornell Experiment Station workers in their now wellknown series of dusting experiments, at the conclusion of which, in 1915, they stated that, even with the inadequate machinery and crude materials used; "it now seems settled that a mixture of an insecticide and fungicide can be applied in the powdered form, using the air as a carrier with better commercial results for the control of preventable apple diseases and of apple insects than can be obtained by spraying. At the same time, the dust method makes it possible for the owner of a large acreage to protect his orchard at critical times, a thing he has not been able to do with the slow liquid process".- Cornell Bulletin 369, New York State Experiment Station.

It should be noted that Sulphur was used as the fungicide for controlling Apple Scab instead of Bordeaux Mixture. The idea of using Sulphur originated from previous successful experience of the same investigators with the use of Sulphur against Hop Mildew in the hopyards of New York

State.

The officers of the Niagara Sprayer Company of Middleport, N. Y., with whom the writer is and was associated at that time, were firmly convinced that the dusting method as worked out by the Cornell experiments could be improved and perfected so as to make the proposition a thoroughly practical commercial undertaking which would find ready favor with large users of insecticides and fungicides.

The factors determining this conviction were largely:

First: The success of the dusting experiments, which clearly indicated that Sulphur in the dry form was as effective as Sulphur in the liquid form.

Second: Increasing trouble on the part of the growers in securing enough and efficient labor to operate liquid spraying equipment.

Third: The speed and ease with which the dusting operations could be accomplished by the average orchardist.

Fourth: The elimination of dependence on water supply.

Fifth: The evident simplicity and complete reliability of dusters as compared to liquid sprayers.

Sixth: The lightness of dusting equipment in the matter of weight and draft.

Seventh: The large acreage possible to cover in short periods of time thus making possible, timely applications over large acreages for the control of Apple Scab.

Eighth: The fact that ordinary farm help

are opposed to the operation of liquid sprayers while it was considered by those who had used the method that dusting as compared to spraying was an almost "pleasant" operation.

Sulphur being the most successful dust fungicide, and being the basic material of all the successful dusting mixtures, was naturally the first material to receive attention.

Apples and peaches being of principal commercial importance in the sections then becoming interested in dusting machinery and materials, these two fruits were the subject of the first investigations.

Previous laboratory and field experimentation with the Apple Scab disease by Experiment Station Experts as well as the writer, determined beyond question that the fungicidal properties of Sulphur dust were practically directly proportional to the physical fineness of the material.

It was quite definitely determined that pure Sulphur of a physical fineness sufficient so that 95% would pass through a screen having 200 meshes to the lineal inch, was comparable in fungicidal properties to ordinary lime-sulphur solution then in general use. Other important factors also determined the necessity of a 200 mesh Sulphur dust. They were:

First: Distribution and Covering Qualities: Thoroughness of distribution and covering qualities being paramount in the fight against Apple Scab infection, it was quickly seen by field experiments that a much more even and uniform covering could be accomplished by the use of the smoke-like Sulphur cloud than could possibly be accomplished by coarser grades of materials.

The reasons for this are obvious.

Second: Adhesiveness and Sticking Qualities: The treatment with dust for fungicidal purposes being almost wholly a preventative measure made the factor of sticking qualities a highly important one. Field demonstrations showed at once that Sulphur of less than 200 mesh fineness would not adhere well to the fruit and foliage while 200 mesh material actually stayed on the trees longer than liquid sprays especially, if applied under conditions that

ONE OF THE EXPERIMENTAL ORCHARDS at MIDDLEPORT, N. Y.

allowed the dust to "set". These conditions were brought about by dews or light rains following within a few hours after the applications. This factor was responsible later

for the recommendation that the dust be applied in early morning or late evening so as to take advantage of the damp conditions then likely to prevail and thus secure the "set" which seemed desirable for adhesiveness.

Third: Economy of Materials: Experiments with materials of various finenesses showed that 100 pounds of 200 mesh Sulphur would give a thorough coating on about 50 average size apple trees while sulphur of 150 mesh fineness would give the same covering on only about 30 trees.

For this reason, if no other, 200 mesh Sulphur became a necessity in the matter of economy of materials.

From these principal reasons it will be seen that our problem was to produce a pure Sulphur having sufficient fineness that 95% would pass through a 200 mesh screen.

To begin with, the finest Sulphur dust of ordinary commerce at that time was but 80 mesh and no manufacturer had produced any finer product than this in commercial quantities, as far as could be learned.

Special machinery was designed and various equipment experimented with for 2 years in an effort to produce this material. Progress on the problem was continuous but interrupted by many disappointments and losses due to explosions, spontaneous fires and every manufacturing trouble imaginable.

In 1916, however, in spite of all of the trouble experienced, 200 mesh Sulphur was produced in commercial quantities and sold for orchard dusting purposes and each year following, successive gains were made in the

RESULT OF EXPLOSION IN ONE OF THE EARLY SULPHUR GRINDING EXPERIMENTS

quality and fineness of the product. Briefly, the system of manufacture finally hit upon consisted of a series of successive grindings, each reducing the material a little finer and finally separating the fine from the coarse particles by means of air separation which automatically divided the product into various grades of fineness of which 200 mesh material was used for dusting purposes. Danger to life and property in the process has never been completely overcome due to the explosive nature of the Sulphur dust when confined under certain conditions.

The perfection of 200 mesh Sulphur dust gave a decided impetus to the dusting method and excellent results were at once secured by commercial orchardists who used the

material. Experiment Stations in all parts of the country where fruit is grown began to work with dusting and the U. S. Department of Agriculture undertook a number of investigations in various fruit growing sections.

RESULT OF AN EXPLOSION AND FIRE IN ONE OF THE EARLY SULPHUR GRINDING PLANTS

Poisons such as Paris Green and Lead Arsenate had been used for sometime as a direct application by dusting and it was not difficult to secure the production of an extremely fine powdered Arsenate of Lead with physical properties somewhat similar to the Sulphur. The matter of fineness and cubical density of this material held none of the unknown or difficult problems encountered with Sulphur and a suitable poison to use in dusting work was quickly produced. Free

arsenic or water soluble arsenic being detrimental for direct poisoning purposes, this content of the Arsenate of Lead for dusting purposes, was reduced to the lowest possible minimu, with the result that practically no arsenical injury resulted from the use of the material even in excessive quantities, on apples.

On account of the necessity of using combined applications of both fungicide and poison, the same as was in vogue in liquid spraying, the problem of suitable mixtures were next attacked. The combinations used in the early work by the Cornell Experimenters were mixed on a board or in a barrel by means of a shovel and in one or two cases, an ordinary cement mixer was utilized for this purpose.

The first mixtures used in the Cornell experiments consisted of 50% Sulphur, 10% Arsenate of Lead and 40% filler, (in this case Gypsum). Later field experiments as well as commercial experience clearly demonstrated that on apples at least, the use of a filler was undesirable as it did not materially accomplish its object, namely, to reduce the cost of the mixture,but did interfere to some extent with the proper function of the Sulphur. In other words, pure dusting mixtures containing no filler gave better commercial results than mixtures containing fillers.

Our experiments over previous seasons had proven that 90 parts of Sulphur and 10 part of Lead in the mixture had given excellent results. No better results were secured with a mixture containing 15% poison, yet, it was thought wise to recommend the latter mixture to orchardists who were just beginning the dusting work as this at least would insure a

full measure of poison. Largely for this reason, the 85-15 Mixture was most popular at the outset of the dusting work but it is now almost entirely replaced by what is termed the Standard Apple Mixture, namely, 90-10.

The success of the 90-10 Mixture on Apples led to its application on Peaches and other fruits. Experience and experiments here however, soon showed that a certain element of danger to Peach foliage existed in the arsenic content of the material and so, 10% of Hydrated Lime was added to the Mixture to neutralize this possibility. 80% Sulphur, 10% Arsenate of Lead and 10% Hydrated Lime, known as the 80-10-10 Mixture may now be termed the Standard Peach Dusting Mixture.

The commercial production of these Mixtures involved a number of problems which had to be overcome before

[illegible] at [illegible], N. Y.

the product could be marketed. Special machinery for mixing the various materials was designed and after a considerable period of factory experience, homogenously mixed and therefore dependable mixtures were produced.

It may be readily seen that disaster would result if materials were improperly mixed. as, one tree might receive all the Arsenate of Lead, and another tree all Sulphur and vice versa. Other problems to be overcome in mixing were the obtaining of materials and fillers of nearly equal fineness and nearly equal specific gravity so that a separation would not occur when the dust was blown from the machine into the air.

In 1916, the perfected mixtures of Arsenate of Lead and Sulphur were marketed and excellent commercial results were secured. This again gave further impetus to the method.

Dusting, by this time, had gained a great commercial momentum and the demand became very urgent for a material that could be used in the Mixtures as a contact insecticide against such sucking insects as Pear Psylla, Apple Aphis, Red Bug, etc.

To meet this demand, manufacturing experiments were begun upon the grinding of tobacco stems to a powder having 200 mesh fineness. In a few weeks the desired product was produced and field experiments on Aphids and Pear Psylla were then begun. These covered a period of two years.

Tobacco stem dust was used experimentally in three distinct manners:

First: The clear Tobacco stem dust.

Second: The simple mixture of 50% Tobacco stem dust and 50% Sulphur.

Third: A mixture of 50% Tobacco dust, 40% Sulphur dust and 10% Arsenate of Lead.

All three of these materials proved to be effective against the sucking insects involved in the field experiments namely, Apple Red Bug, Green Aphis and Pear Psylla. At the conclusion of the experiments, the combined mixtures containing Tobacco dust for contact insecticide were placed

ONE OF THE ORCHARDS AT SIMCOE WHICH HAS LENT ITSELF TO THE TESTING EXPERIMENTS

on the market and met with a large demand. Unfortunately, varying results were secured by commercial orchardists in the matter of effectiveness and these materials again came under close investigation. Observation of results secured together with laboratory analysis of the tobacco dust gave the solution of the trouble, namely; the nicotine content of the Tobacco stem varied so greatly that a uniform and homogeneous nicotine content in the mixture was not possible.

The next logical step seemed to be to make a material in which the nicotine content could be controlled accurately. Black Leaf 40 or Nicotine Sulphate had proved so effective a contact insecticide in the liquid form that the possibilities of this product were first investigated with the result that laboratory and factory tests showed that Nicotine Sulphate could be impregnated into Sulphur to pro-

duce a known and constant nicotine content of as high as 2% while the highest average nicotine content of the best Tobacco stems was but one-half of one percent. By adding a small percentage of Plaster Paris to the mixture to assist in drying, the material retained its fluffy fineness and was entirely suitable for dusting purposes.

This new product was placed under experimental field conditions at once and also given out to a number of commercial growers where it was used under supervision. Excellent results were secured and thus the various materials required for the summer treatments of Apples and Peaches seemed complete. An excellent fungicide, Sulphur, could be combined with an excellent stomach poison, Arsenate of Lead and when occasion required, a strong and effective contact insecticide, Nicotine could be added.

By the time developments in the method had reached this stage, many commercial orchardists had replaced worn out liquid spraying equipment with dusting machines without giving thought to the matter of dormant applications to the apple orchards for the control of San Jose scale.

While in most principal orchard sections, the San Jose scale had been largely eradicated, the problem of furnishing duster users with materials suitable for dusting which would control San Jose scale, became so acute that investigations were at once begun with various chemicals to locate something that would answer the requirements. Several powders known to be effective against San Jose scale when used in the form of solution, were tried out without effective results.

Finally, however, after a series of difficult

factory experiments in the matter of grinding to sufficient fineness for practical use, a very fine sodium polysulphide was produced which, when mixed with 25% of inert filler (Hydrated Lime), gave an excellent dust from the point of view of physical properties.

This material was not deliquescent when in massed form but when blown out of the machine in a fine smoke-like cloud, especially on damp days, the tiny particles of sodium polysulphide turned to a semi-fluid and readily stuck on the dormant trees even of smooth bark. Large trees were effectively covered by dusting from two sides only.

Careful check proved that 98% control was secured on infestations which were very serious in two of the experimental orchards. Commercially, the material has been widely used, in a small way, by growers who had fundamentally clean orchards with reference to San Jose scale but who experienced minor infestations in certain small areas of the orchard from time to time.

The development of this dormant dust obviated the necessity for both liquid and dust equipment and was very instrumental in leading to the adoption of the new method by many growers who could not see their way clear to own and operate both the liquid spraying and dusting machines.

Such diseases of Apples as Bitter Rot and Apple Blotch which have not been considered to be susceptible to Sulphur treatments either in the liquid or the dust form have come under consideration during the past two years. Bordeaux Mixture liquid, being effective against these diseases it was determined to begin a series of experiments to ascer-

tain whether Bordeaux powder of 200 mesh fineness would not be equally effective as a dust.

Orchards were selected in Virginia where both of these diseases are prevalent for this work. Experiments were conducted with a mixture containing 25% powdered Bordeaux Mixture which contained in turn, 11% metallic copper. The results secured were negative but clearly indicated that a stronger Bordeaux powder would give effective results.

Field experiments are now in progress with a powdered Bordeaux Mixture of 22% metallic copper content and also with a mixture containing dehydrated pure copper sulphate powder. Should these series of experiments prove successful, which they undoubtedly will, dusting will have been made a complete substitute for liquid spraying for practically all of the preventable Apple and Peach diseases and insects.

In 1914, when experiments on the improvement of Sulphur were begun, work was also started on the design of a suitable dusting machine for applying the fine materials properly and thoroughly to the trees. All types of existing machinery for dusting purposes were secured and experimented with under field conditions, in one of the experimental orchards.

The whole season was spent in this work and the experience offered many suggestions for overcoming known weaknesses in the dusting machines and adding refinements to the design of the proposed new machine.

Summing up this field experience with handling the available dusting equipment in 1914, it became apparent that all existing types of dusters were entirely inadequate to meet the situation and that in order to be successful

in handling the materials then in process of production for dusting purposes, a practical dusting machine must at least embody the following general features:

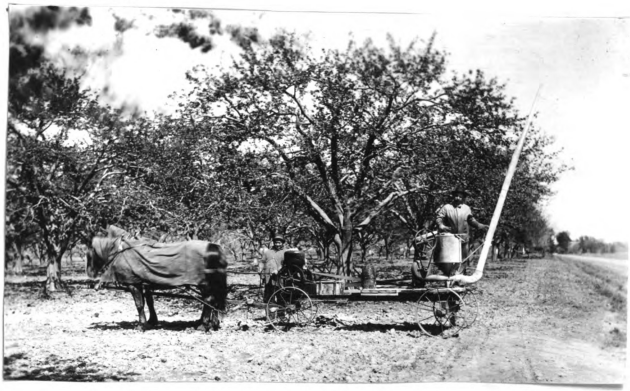
First: An outfit for dusting should be light in weight yet sturdily built and absolutely reliable, so delays at critical periods would not be experienced by the nedessity of repairs and adjustments. Extra strength of construction was also considered essential because the dusting machine would be subjected to rough usage by the fact of its being drawn more or less rapidly over rough orchard land while in full operation.

Second: It should have a hopper of sufficient capacity to hold at least 100 lbs., of the finest dust and should be provided with a dust-tight cover sufficiently large to allow the mouth of the bag of material to be introduced directly to it for filling purposes so as to avoid waste from spilling or loss of material by secondary transfer from containers into the hopper.

Third: It should have a feeding device which would give an even and steady flow of materials and which would be susceptible of very fine and accurate adjustment by the operator so that the amount of material applied might be easily regulated.

Fourth: A provision should be made for breaking up the tiny "balls" of Sulphur and other materials before the dust leaves the discharge pipe. The "balls" are formed by a mass of tiny particles clinging together and are easily broken up by slight crushing. If the dust were allowed to be thrown out of the machine without breaking all of these tiny"balls", as in the case of all machines tested, great

waste of material would result and the "balls" would roll off the foliage without sticking, thus resulting in an irregular distribution.



ONE OF THE OLD STYLE DUSTERS USED BY T. H. "EXPERIMENT" FARM OF 1914

Fifth: It should be provided with a fan for producing the air current which would give a sufficient blast to carry the dust to the highest trees and yet require a minimum of power to rotate it in order tokeep down the weight and size of the necessary power plant. Bearings for such a fan should be of a type that would allow of at least 2500 revolutions per minute with a minimum of attention to lubrication.

Sixth: A clutch or similar device should be provided to allow the duster to be disengaged from the power plant so that the hopper might be replenished without stopping and starting the engine.

These six principle features then, were found by field experience to be essential to a successful dusting machine and experiments were begun with various devices to accomplish the perfection of a machine embodying all of these features.

None of the machines which were available had any of these essential features even in a half successful way so that practically all of the final results in improved dusting machines were accomplished by shop experimentation and field tests.

The first improved duster produced for commercial purposes had all of the features considered to be essential to a successful dusting machine and was a marked improvement on all existing types.

First: The machines were light weight; weighing only about 700 pounds with engine complete. They were simple and built of the best materials obtainable and hence were reliable. For example, all bearings were made of babbitt metal except the fan bearings which were made of the best bearing bronze while the previous types of dusters carried nothing but cast iron bearings.

The machine was mounted on a three point suspension principal as low as possible and thus eliminated at once the danger of disalignment of the various working parts by twists and strains while in operation.

Second: The hopper had sufficient cubic capacity for holding one hundred pounds of the finest dust and the opening for filling was amply large. The hopper was dust-tight in every way.

Third: The feed was accomplished by means of a

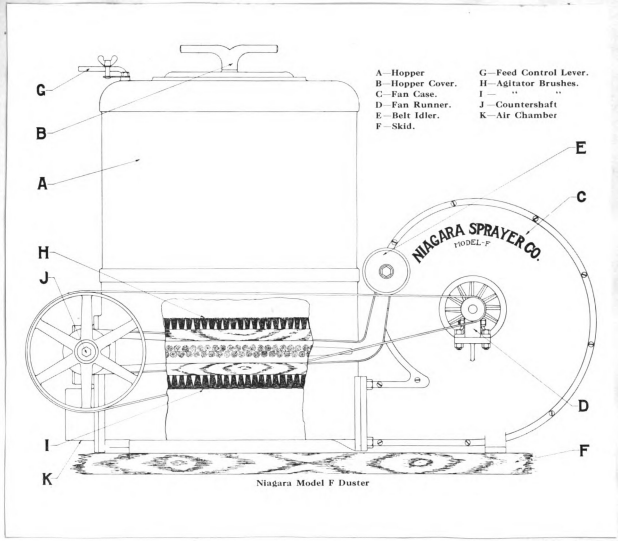


DIAGRAM OF IMPROVED DUSTER

revolving cylinder of brushes which forced the material through a perforated plate thereby crushing all lumps before the dust finally fell into the air chamber at the bottom of the hopper.

Beneath the perforated plate at the bottom of the hopper was a feed regulator consisting of two diagonally slotted slides working over each other. The position of the slides was controlled by a small hand lever conveniently located at the end of the hopper near the discharge pipe. The operator was thus permitted to regulate the amount of material to be discharged. The plate and slides were made of a

metal which would resist the corrosive action of Sulphur and other chemicals which were used for dusting purposes.

Fourth: The fan was constructed of aluminum metal giving great strength and lightness and the bearings were designed of the self-oiler type same as used on high speed electric motors. They were made of the best bearing bronze and were enclosed in a housing which was absolutely dust-tight. These bearings, it will be readily seen, required a minimum of attention in the matter of lubrication.

Fifth: An expansion band clutch was provided which allowed the engine to be disengaged when necessary, such as in driving from place to place, changing position, refilling the hopper, lubricating, etc.

The first improved dusters were so light and simple that it was considered that one horse could draw the outfit, therefore, the equipment consisted of shafts instead of a pole. The larger types of machines designed later, however, required the use of a team.

and for this reason, the single hitch was entirely discontinued.

The manner of mounting machines on the wagons was a problem which passed through many varying stages of development. First the duster was mounted in front on the wagon and the engine next to the operator who was on the rear and who was protected by means of a railing about waist-high. This idea was, of course, descended directly from the old spray towers. This arrangement was quickly improved as it was evident that with the operator on one end

of the wagon and the duster on the other end, the flow of materials could not be regulated conveniently. The railing guards were also found to be entirely unnecessary. Therefore, the dusters were next mounted by placing the engine ahead of the duster but in order to

accomplish this change, it was necessary to introduce a countershaft on the machine. The railing was discontinued and the long flexible rubber hose was replaced by sheet metal pipe about six feet long, connected to the duster by means of a short flexible piece of rubber and wire coupling.

The dusting method now was meeting with such favor that many orchardists having large commercial acreages of matured trees were adopting the method, and they demanded a larger and more powerful type of outfit. Therefore, the discharge pipe was increased to four inch diameter instead of three and the fan capacity was trippled. This type of high power duster met with immediate success and is now the standard size machine for general dusting work.

A few mechanical refinements were added to the dusters each succeeding year, but the only important new development after 1918 was the adoption of the drop platform idea in mounting the outfits. Trouble had al-

ways been experienced by orchardists in being brushed off of the machine by lowhanging branches and in many orchards, the problem seriously interfered with good work. By dropping the operator's platform on the rear of the machine, down below the platform of the wagon, this objectionable feature was practically overcome and better applications were generally made because of the greater freedom and ease of the operator.

EARLY 1 [illegible] BUILT IN 1913 SHOWING FAN HOUSING AND DUST [illegible]

After the commercial success of the dusting method had become assured, variations in the standard machines were made, to meet different special conditions brought about by the treatment of such crops as Strawberries, Potatoes, Cabbage, Tomatoes, Ornamental Shrubbery, Gardens, Cotton, Tobacco, Walnuts, Parks and Shade Trees, Citrus, etc., by the dusting method. The mention of a few of these adaptations which were accomplished by field experiments will typify the many which have been made for all the various kinds

of work in which dusting has been found to be successful.

The dusting of Strawberries, Potatoes and similar rowed crops, on a large scale, made it necessary to develop a distributor for the dust which would place the discharge of the material directly over the rows and allow several rows to be treated at one time. It was also necessary to discharge the dust close to the plant to obtain the desired results. A distributing system was devised for this work consisting of three to five individual nozzles hanging from the rear of the machine and connected to the main discharge by rubber tubing and galvanized metal pipe. The device worked perfectly under field conditions.

A slight refinement was added to this distributor when the cotton dusting machines were developed by making it possible to raise and lower the nozzle from the driver's seat by means of a hand lever.

To meet the demand for a hand operated duster, of about similar capacity to the wellknown barrel spray outfit, for the treatment of Small Trees, Truck Crops, Cabbage, etc., where a large power machine would not be necessary or practical, "the blower gun" was developed in 1918. The "blower gun" embodies all of the essential features of the large power dusting machine including the brushing and feeding device. In operation, it hangs from the shoulders of the user directly in front of him and obtains its power from a fan which is rotated by a hand crank operating a gear set.

IMPROVED GRAIN TREE DUSTER-1919

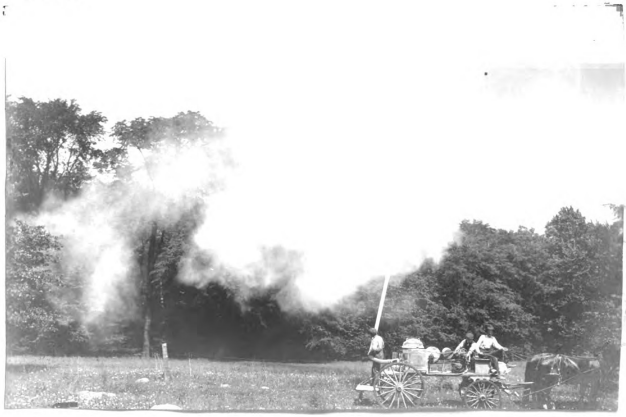
This improved type of hand operated duster has made possible the general use of the dusting method by many small growers and planters who heretofore have considered the muss and fuss of liquid spraying as being too much trouble and too complicated for small properties.

Amateur gardeners, owners of homes having ornamental plants and shrubbery about the grounds, etc., were also turning to the dusting method as an easy and efficient means of ridding their places of "bugs" and diseases. It was considered that the blower gun was too large and too expensive for this type of dusting work so a small hand dust outfit was developed which had no fan but which consisted of an air chamber and plunger, which, when pushed backward and forward by the operator, created an air pressure sufficient to throw a tiny cloud of dust from the small hopper of the machine.

IMPROVED PLUNGER TYPE HAND DUST GUN IN OPERATION

On account of the ravages of shade tree pests in various parts of the country, particularly in New England, and the almost numberless difficulties encountered in fighting these pests by liquid sprays, it

seemed wise to attempt to develop a proper duster for this work. Consequently, a huge duster operated by an eight horse power gasoline motor was designed. All of the principles used were the same as with the standard orchard machines except for the size and capacity of the various parts. Extensive field experiments were carried on in the Buffalo, N. Y. Parks with one of these outfits and surprisingly effective results were secured the first season against Tussock Moth, with a mixture of 80% Lime and 20% Arsenate of Lead. The highest elm trees were readily reached and thoroughly covered with the dust and treatments were possible in thickets and heavily wooded second growth sections which heretofore were impractical to spray.



The improvement of dusting machines and materials for using dry insecticides and fungicides with air as a carrier instead of water, was accomplished by a series of successive steps beginning first with a scientific analysis of the actual field requirements of such machines and materials and slowly perfected by closely collaborating practical field experiments, technical laboratory experiments and factory practice in the manufacture of the products. The usual process being:

First: Extensive field and laboratory tests to determine the practicability of proposed machines or materials.

Second: If these experiments were successful, factory tests were begun to determine the feasibility of manufacturing such machines or materials for commercial purposes.

Third: If these factory experiments were successful, the finished manufactured product was again proved by field and laboratory experiments before the machines and materials were turned over to orchardists for commercial use.

When the improvement of dusting machines and materials was undertaken by the writer and associates in 1915, there were, as far as could be learned, less than one hundred fifty dusting machines of all types in commercial use for orchard fruits. On January 1st, 1920, there were as far as could be learned, about five thousand of these improved machines in the hands of commercial orchardists in the United States and Canada. Practically every Experiment Station

in the fruit growing states was working with dust in one way or another and the United States Department of Agriculture had underway about twenty-five distinct experiments in various parts of the country. Greater improvements in both machines and materials than have already been accomplished will unquestionably come and with the impetus already given to this method of treatment, it is certain that during the next few years, dusting, by virtue of its many peculiarly advantageous features, will practically replace liquid spraying as a means of protecting commercial orchards agains the depredations of injurious insects and diseases.

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