



Useful Information

on

fumigation

OF CITRUS TREES

for

Growers and Fumigators

Compiled by The Pacific R & H Chemical Corporation

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interested in the art.

We have attempted to assemble information secured from authoritative sources together with data from our own research and experiences in the laboratory, factory, and field. This booklet is not intended as a treatise on fumigation, monographs of which are to be found in government, state and university publications, but more as an assembly of useful facts for the guidance of the fumigator and grower.

For many years our company has supplied citrus grower and fumigator with fumigating materials and appliances. Within recent years we have established a factory in the midst of the citrus industry in order that we might better serve you by providing a dependable supply of uniform high grade products. This dependable supply, together with our facilities for prompt delivery, places us in a position to serve you well and we solicit your valued patronage.

your part.

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To Citrus Growers and Fumigators

In presenting this booklet on fumigation to the trade we do so with the hope that it will prove useful to those who are

All orders placed with us either by mail or telephone will receive our prompt and careful attention. Our representatives will be glad to call upon request to discuss with you fumigation matters and this service is renderd without any obligation on





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Fumigation is the art of applying a fumigant to an enclosed area. Fumigation as usually performed on citrus trees is the art of applying the gas or vapor of hydrocyanic acid to scale insects at suitable concentration and over sufficient periods of time to kill the scale.

As successfully practiced today in California, fumigation of citrus trees The purpose of fumigation is to kill the scale and insect life which

is accomplished by completely enclosing the scale infested tree with a canvas tent and charging the confined area with hydrocyanic acid. This deadly poison is introduced to the enclosed tent either as a liquid or in gaseous form. infests the tree. The art has been fairly well standardized due to the introduction of hydrocyanic acid and most authorities concede the superiority of this material as the most practical and efficient fumigant for controlling scale insects.

Fumigation with hydrocyanic acid, in common with other insect control methods, has had its failures, but these failures have been far fewer in proportion to its extensive use than for any other method. The success of fumigation, its marked superiority over other methods of control, and the definite results obtained prove its effectiveness and recommend it as the most efficient and economical method of combating the scale insect pests. Fumigation is the only positive method known today for successfully ridding citrus trees of scale pests and maintaining orchards in a commercially clean condition.

Methods of Applying Hydrocyanic Acid

The chief sources of gaseous hydrocyanic acid are 1. Potassium or Sodium Cyanide (cyanegg) (a) Generation of the gas by the pot method. (b) Generating the gas in a portable generator of the "Gyanofumer" type. 2. Liquid Hydrocyanic Acid (Hydro-Cy). (a) Atomizing method, the liquid applied as a fine spray with the Hydro-Cy Pump. (b) Vaporizing method, Hydro-Cy converted into a warm gas and applied as such with the Hydro-Cy Vaporizer.

In the pot method of fumigation hydrocyanic acid gas is generated from potassium or sodium cyanide (cyanegg) and sulphuric acid and water, the chemicals being mixed in earthenware pots. These pots are of about 3 gallons capacity. In general practice, the pot, containing the required amount of sulphuric acid and water, is placed under the tented enclosure. To the contents of the pot is then added the weighed amount of cyanide. In order to facilitate this operation, sodium cyanide is manufactured in egg form, each egg weighing approximately one ounce, thus making it unnecessary to weigh the cyanide. The operator merely counts the number of eggs (ounces of cyanide) called for by the dosage chart and places them in the pot containing the measured quantity of sulphuric acid and water. The proportions of cyanide, acid and water most generally used are 1:11/2:2. That is, for each ounce of cyanide, one and one half fluid ounces of acid and two fluid ounces of water are required.

Fumigation

Pot Fumigation



Cyaneggs and Receptacles Required for Pot Fumigation

Pot fumigation was the standard method employed for a number of vears until finally displaced by the introduction of the portable generators.

Advantages

Safe in that the mixing of the chemicals is made in the field at the time and place when and where the gas is desired. That is, the chemicals are not mixed until the pot is placed under the tent and the tree is ready to be fumigated.

The operation is simple and easily carried out by labor of ordinary intelligence. No skill is required in handling the chemicals.

The grower finds it comparatively easy to follow and check the work of the fumigator as he has no difficulty in understanding the operation and by counting the number of eggs of cyanide placed in the pot knows at once the dose that the tree is receiving.

There is no storage problem attached to the handling of cyanegg or sulphuric acid so that growers or associations can purchase these supplies direct from the manufacturers or supply companies and supply the fumigator with the material when needed.

Disadvantages

Pot fumigation is not as economical to the grower as the other methods in that the consumption of sulphuric acid is greater, labor costs are higher and the fumigator must increase his covering charges because of the greater wear and tear on the tents.

The pot method is not as effective because of the slow generation of the gas from the chemicals in the pot and because of the lack of uniform distribution of the gas under the tent, the tendency being for the gas to go to the top of the tent whence it diffuses downward at a very slow rate. Hence with pot fumigation good kills can be expected at the top and possibly the center of the tree while unfavorable results may be looked for in the lower half of the tree. It is in the lower half of the tree that most of the scale insects are to be found.

The method is not as convenient and requires a greater investment on the part of the fumigator or association than does the newer method employing liquid hydrocyanic acid (Hydro-Cy).

From the standpoint of the grower the dumping of the residue from the pots in the orchard is detrimental in that there is danger of the residue, which is strongly acid, being placed too close to a tree oftentimes causing injury to the tree.

Fumigation with Portable Generators

In this method of fumigation hydrocyanic acid is generated from solutions of sodium cyanide (cyanegg) and sulphuric acid in a generator stationed outside the tent. The best known type of portable generator is the "Cyanofumer." The principle on which the construction of this machine is based is that small successive quantities of cyanide solution are added to



The machine, as shown in the accompanying illustration, consists

a large amount of sulphuric acid and water until the acid is nearly exhausted. essentially of two tanks bolted together one above the other. In the lower tank is placed the sulphuric acid and water and in the upper one the cyanide solution. By the action of a measuring pump, measured quantities of cyanide solution are forced into the tank containing the acid and water; the gas is generated instantaneously and discharged through the delivery hose under the tent.

The measuring pump is graduated on the basis of a standard solution of cyanide made by dissolving 200 lbs. of cyanegg (96-98% sodium cyanide) in 50 gallons of water. The water and acid are added to the lower bowl in the proportion of one part of water to one part of acid, the water and acid being introduced into the bowl in the order named.

For conveniently handling the chemicals in the warehouse and in the field and in preparing the cyanide solutions, accessory equipment is necessary. Among the accessories which are needed may be mentioned cyanide solution tanks, solution carrier cans or drums, acid pitchers, etc.

Fumigating With the Portable Generator

Advantages and Disadvantages of Portable Generators

The advantages possessed by the portable generators over the somewhat crude and cumbersome pot method of fumigation are that fumigation can be carried on more quickly and with greater accuracy. The method of generating the gas is positive, quick and safe and a warm gas is delivered under the tent.

As in the case of the pot method, the chemicals are reasonably safe to handle and the poisonous gas is not generated until needed for fumigation.

Labor costs are reduced in that one man less per crew is required.

Results from this method of fumigation are uniformly better than in the pot method since the charge, as a gas, is introduced more quickly and a more uniform distribution of the gas within the tent takes place.

Among some of the disadvantages of the portable generators may be cited the following:

The heavy upkeep charges due to the mechanical wear and tear on the equipment and to the burning of tents with the acid which is frequently ejected from the generator along with the gas.

The necessity and bother attached to preparing cyanide solutions in advance and cost entailed in transporting solutions and acid to the field.

The difficulty of disposing of the residue from the generator. Many growers will not permit the acid residue to be dumped in the orchards on account of the danger of killing trees.

The lack of complete uniformity of treatment of each tree from the beginning to the end of the throw. As the machine of the portable generator proceeds down the row, the same quantity of gas for a given charge of cyanide is not evolved, part of the gas being absorbed in the residue. The amount of gas absorbed depends on the temperature and dilution of the residue, the lower the temperature and the greater the dilution, the greater the volume of gas absorbed. In addition, a lower temperature and dilution of the residue due to the introduction of the water along with the cvanide, results in a slower generation of the gas and hence a longer time is required to introduce it under the tent with a consequent drop in the efficiency of the process.

On account of their weight and size portable generators cannot be as conveniently handled in the orchard as the newer and later types of equipment employed which use liquid hydrocyanic acid.

Chemicals for Pots or Portable Generators

For the generation of hydrocyanic acid from pots or portable generators, a high grade cyanide, sulphuric acid and water are required. The following grades of chemicals are recommended:

"Cyanegg," 96-98% sodium cyanide in egg form, each egg weighing approximately one ounce. "Cyanegg" is packed in air tight cases containing 100 lbs. and 200 lbs. net per case; 200 lb. cases are the most practical in fumigation work. Cyanegg can be purchased in lots of 100 lbs. or more. Prices will be given on application.

Sulphuric Acid. Commercial concentrated sulphuric acid of about 1.84 specific gravity or 66° Baume should be used. The acid can be obtained in carboys, drums or tank cars, from the following local manufacturers: American Agricultural Chemical Co., General Chemical Co. and Stauffer Chemical Co. Each carboy contains approximately 180 lbs., drums hold between 1550 and 1600 lbs.

Fumigation With Liquid Hydrocyanic Acid

Liquid hydrocyanic acid is produced on a commercial scale by treating cyanide compounds with sulphuric acid and water and subjecting the gas which is generated to processes of distillation and liquefaction. The home of "Hydro-Cy" is shown in the frontispiece.

Some Physical and Chemical Properties of Hydro-Cy

"Hydro-Cy" is the trade name under which our brand of liquid hydrocyanic acid (Prussic acid) is marketed. Hydro-Cy is a water white liquid ranging in purity from 96% to 98% HCN (hydrocyanic acid).

material to 0.703 for 96% HCN. One gallon of Hydro-Cy (97% HCN) at 68° F. (20° C.) weighs 5.825 lbs. (This has been calculated by taking the density of 97% Hydro-Cy at 68° F. as 0.700 and using the value of 8.322 pounds as the weight of one gallon of water at 68° F. (20° C.).

is 26.9° C (80.4° F.).

 -17° C. (+1.4° F.).

Hydro-Cy is miscible with water in all proportions. When once thoroughly mixed, the liquid remains homogeneous throughout, except as affected by chemical decomposition.

Hydro-Cy is inflammable. It will burn when ignited in much the same manner as alcohol burns. Precautions should, therefore, be taken to keep all open flames away from exposed containers or liquid. Hydrocyanic acid gas when mixed with air or oxygen in the right proportions forms an explosive mixture which when ignited detonates with great violence.

Hydrocyanic acid is not a very stable compound, the liquid decomposing, upon standing, into a bulky black solid much resembling carbon. Most impurities tend to promote decomposition of the liquid. Alkali compounds, soap, sodium cyanide and many farm yard materials are especially favorable to decomposition. If the liquid is confined in a container and starts to decompose, gases are liberated which, if not allowed to escape, will oftentimes develop sufficient pressure to burst the container.

Liquid which is undergoing decomposition can be detected by its color. When the liquid starts to decompose, a faint yellow color is imparted to it, which deepens as the decomposition progresses until finally the color merges into deep brown. During the process of decomposition, gases are formed, chief among which is ammonia. Liquid which is undergoing decomposition should be used immediately and not allowed to remain in places of storage, or should be returned to the producer at once.

Specific Gravity Tables

Hydro-Cy is sold under a guarantee that it is 96-98% pure. Customers are asked to verify this guarantee by testing the liquid shortly after it has been delivered. It is important for the fumigator to know that he is using liquid of a uniform guaranteed quality as he is paying for it on the weight basis.

Its specific gravity at 68° F. (20° C.) ranges from 0.696 for 98%

The boiling point, at atmospheric pressure, of Hydro-Cy (97% HCN)

Hvdro-Cv (97% HCN) freezes or becomes solid at approximately

bserve	ed 0	1	2	3	4	5	6	7	8	9	10	11	12
p. or		<u></u>	1	PER	CENT	HYDE	ROCYA	NIC A	CID	1.1			
.682]			••••				
.683													
.685													
.686													
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.693													
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.696													
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.698													
700								-		ing Seal			i the second
.701													100.0
.702													99.7
.703											99.9	99.8	99.4
.705										100.0	99.6	99.2	98.8
.700									99.9	99.1	99.0	98.6	98.2
.708								100.0	99.6	99.1	98.7	98.3	97.9
.709								99.7	99.3	98.8	98.4	98.0	91.5
.710							99.8	99.4	99.0	98.5	98.1	97.7	97.2
.712						99.7	99.5	99.1	98.7	98.2	97.8	97.4	96.9
.713					99.8	99.4	98.9	98.5	98.1	97.6	97.2	96.8	96.3
.715			100.0	99.9	99.5	99.1 98.8	98.6 98.3	98.2	97.8	97.3	96.9	96.5	96.0
.716			99.7	99.3	98.9	98.4	98.0	97.6	97.1	96.7	96.3	95.9	95.4
.718	100.0	99.8	99.4	99.0	98.0	98.1 97.8	97.4	97.3	96.8	90.4 96.1	96.0 95.7	95.0 95.3	95.1
.719	99.6	99.2	98.8	98.4	97.9	97.5	97.1	96.7	96.2	95.8	95.4	95.0	94.5
.720	99.3	98.9	98.5	98.1	97.6	97.2	96.8	96.4	95.9	95.5	95.1	94.7	94.2
.722	99.0	98.0	98.2	97.4	97.3	96.9 96.6	96.5	96.0 95.7	95.6	95.2 94.9	94.8 94.5	94.3 94.0	93.9
.723	98.4	98.0	97.5	97.1	96.7	96.3	95.9	95.4	95.0	94.6	94.2	93.7	93.3
.725	97.8	97.3	96.9	96.8	96.4	96.0	95.6	95.1 94.8	94.7	94.3	93.9	93.4 93.1	93.0 92.7
.726	97.4	97.0	96.6	96.2	95.8	95.4	94.9	94.5	94.1	93.7	93.2	92.8	92.4
.728	96.8	96.4	90.3	95.9	95.5	95.1 94.8	94.6	94.2	93.8	93.4	92.9	92.5	92.1
.729	96.5	96.1	95.7	95.3	94.9	94.5	94.0	93.6	93.2	92.7	92.3	91.9	91.5
.730	96.2	95.8	95.4	95.0	94.6	94.2	93.7	93.3	92.9	92.4	92.0	91.6	91.2
.731	95.9	95.5	95.1	94.7	94.2	93.8	93.4	93.0	92.6	92.1	91.7	91.3	90.9
.733	95.3	94.9	94.5	94.0	93.6	93.5	93.1 92.8	92.7	92.3	91.8	91.4	91.0	90.8
.734	95.0	94.6	94.1	93.7	93.3	92.9	92.5	92.1	91.6	91.2	90.8	90.4	90.0
.736	94.3	93.9	93.5	93.4	92.7	92.0	92.2	91.8	91.3 91.0	90.9	90.5	90.1 89.8	89.1
.737	94.0	93.6	93.2	92.8	92.4	92.0	91.6	91.1	90.7	90.3	89.9	89.5	89.1
.739	93.4	93.0	92.9	92.5	92.1 91.8	91.7 91.4	91.2	90.8	90.4	90.0 89.7	89.6 89.3	89.2 88.9	88.8
.740	93.1	92 7	92 2	01.0	01 5	01.4	00.1	00.0	00.1	00.1	00.0	00.7	00.0
.741	92.8	92.4	92.0	91.6	91.2	91.1	90.6	90.2 89.9	89.8	89.4	89.0 88.7	88.0	88.2
.742	92.4	92.1	91.7	91.3	90.9	90.5	90.0	89.6	89.2	88.8	88.4	88.0	87.6
.744	91.8	91.4	91.0	90.6	90.2	89.9	89.1	89.3	88.9	88.5	88.1	87.0	87.3
.745	91.5	91.1	90.7	90.3	89.9	89.6	89.1	88.7	88.3	87.9	87.4	87.0	86.7
.747	90.9	90.5	90.1	89.7	89.3	89.0	88.5	88.4	88.0	87.6	87.1	86.7	86.0
740	90.6	90.2	89.8	89.4	89.0	88.7	88.2	87.8	87.3	86.9	86.5	86.1	85.7
47	71.												

. Gr.	13	14	15	16	17	18	19	20	21	22	23	24	25
				PER	CENT	HYDE	OCYA	NIC A	CID				
82 .]										100.0
83 .													99.
85											100.0	99.6	99.
586											99.7	99.3	98.
687 .										99.9	99.4	99.0	98.
88 .									100.0	99.6	99.1	98.7	98.
. 209							* * * * * * *		99.1	99.5	90.0	90.4	91.
690 .								99.8	99.4	99.0	98.5	98.1	97.
591 ·		• • • • • •					100.0	99.5	99.1	98.7	98.2	97.8	97.
693						99.8	99.1	98.9	98.5	98.1	97.6	97.3	96.
694 .					100.0	99.5	99.1	98.6	98.2	97.8	97.4	97.0	96.
695 .					99.7	99.2	98.8	98.3	97.9	97.5	97.1	96.7	96.
696				99.8	99.4	98.9	98.5	98.0	97.0	91.2	90.8	90.4	90.
698		100 0	99.9	99.3	98.8	98.3	97.9	97.5	97.1	96.6	96.2	95.8	95.
699 .		99.7	99.3	98.9	98.5	98.0	97.6	97.2	96.8	96.3	95.9	95.5	95.
700	00 8	00 4	00.0	08 6	08 2	07 7	07 3	06.0	06 5	96.0	95 6	95.2	94
701	99.5	99.1	98.7	98.3	97.9	97.4	97.0	96.6	96.2	95.7	95.3	94.9	94.
702	99.2	98.8	98.4	98.0	97.6	97.1	96.7	96.3	95.9	95.4	95.0	94.6	94.
703	98.9	98.5	98.1	97.7	97.3	96.8	96.4	96.0	95.6	95.1	94.8	94.3	94.
704	98.0	98.2	97.8	97.4	97.0	90.5	90.1	95.1	95.3	94.8	94.5	93.8	93
706	98.0	97.6	97.2	96.8	96.4	95.9	95.5	95.1	94.7	94.2	93.9	93.5	93.
707	97.7	97.3	96.9	96.5	96.1	95.6	95.2	94.8	94.4	94.0	93.6	93.2	92.
708	97.4	97.0	96.6	96.2	95.8	95.3	94.9	94.5	94.1	93.7	93.3	92.9	92.
709	97.1	96.7	96.3	95.9	95.5	95.0	94.6	94.2	93.8	93.4	95.0	92.0	92.
710	96.8	96.4	96.0	95.6	95.2	94.7	94.3	93.9	93.5	93.1	92.7	92.3	92.
711	96.5	96.1	95.7	95.3	94.9	94.4	94.0	93.6	93.2	92.8	92.4	92.1	91
712	96.2	95.8	95.4	95.0	94.0	94.1	93.1	93.3	92.9	92.5	91.8	91.5	91
714	95.9	95.5	95.1	94.1	94.0	93.5	93.2	92.7	92.3	91.9	91.6	91.2	90
715	95.3	94.9	94.5	94.1	93.7	93.3	92.9	92.5	92.1	91.7	91.3	90.9	90.
716	95.0	94.6	94.2	93.8	93.4	93.0	92.6	92.2	91.8	91.4	91.0	90.6	90.
717	94.7	94.3	93.9	93.5	93.1	92.7	92.3	91.9	91.5	91.1	90.7	90.3	80
719	94.4	94.0	93.0	93.2	92.0	92.4	92.0	91.3	90.9	90.5	90.1	89.8	89
	21.1	30.1	10.0		00.0	04.0		01.0	00.6	00.2	80.8	80 5	80
720	93.8	93.4	93.0	92.6	92.2	91.8	91.4	91.0	90.0	80.0	89.5	89.2	88
722	93.5	93.1	92.1	92.5	91.6	91.3	91.1	90.4	90.0	89.6	89.2	88.9	88
723	92.9	92.5	92.1	91.7	91.3	90.9	90.5	90.1	89.7	89.3	89.0	88.6	88
724	92.6	92.2	91.8	91.4	91.0	90.6	90.2	89.8	89.4	89.0	88.7	88.3	87
725	92.3	91.9	91.5	91.1	90.7	90.3	89.9	89.5	89.1	88 4	88 1	87.7	87
720	92.0	91.0	91.2	90.8	90.4	89.7	89.0	88.9	88.5	88.1	87.8	87.4	87
728	91.4	91.0	90.6	90.2	89.8	89.4	89.0	88.6	88.2	87.8	87.5	87.1	86
729	91.1	90.7	90.3	89.9	89.5	89.1	88.7	88.3	87.9	87.6	87.2	86.8	8,6
730	90 8	90.4	90.0	89 6	89.2	88.8	88.4	88.0	87.6	87.3	86.9	86.6	86
731	90.5	90.1	89.7	89.3	88.9	88.5	88.1	87.7	87.3	87.0	86.6	86.3	85
732	90.2	89.8	89.4	89.0	88.6	88.2	87.8	87.4	87.1	86.7	86.3	80.0	85
733	89.9	89.5	89.1	88.7	88.3	87.9	87.5	87.1	80.8	80.4	85 8	85.4	85
734	89.0	89.2	88.8	88.4	87 7	87.3	86.9	86.6	86.2	85.8	85.5	85.1	84
736	89.0	88.6	88.2	87.8	87.4	87.0	86.6	86.3	85.9	85.5	85.2	84.8	84
737	88.7	88.3	87.9	87.5	87.1	86.7	86.3	86.0	85.6	85.2	84.9	84.5	84
738	88.4	88.0	87.6	87.2	86.8	86.4	86.0	85.7	85.3	84.9	84.0	84.0	83
739	88.1	87.7	87.3	86.9	80.5	80.1	85.1	03.4	05.0	04.0	01.0	01.0	00
740	87.8	87.4	87.0	86.6	86.2	85.8	85.4	85.1	84.7	84.3	84.0	83.7	83
741	87.4	87.1	86.7	86.3	85.9	85.5	85.1	84.8	84.4	83.8	83.4	83.1	82
742	87.1	86.8	86.4	86.0	85.0	84 0	84.5	84 2	83.8	83.5	83.1	82.8	82
744	86.5	86.2	85 8	85 4	85.0	84.6	84.2	83.9	83.5	83.2	82.8	82.5	82
745	86.2	85.9	85.5	85.1	84.7	84.3	84.0	83.6	83.2	82.9	82.5	82.2	81
746	85.9	85.6	85.2	84.8	84.4	84.0	83.7	83.3	82.9	82.6	82.3	81.9	81
747	85.6	85.3	84.9	84.5	84.1	83.7	83.4	83.0	82.6	82.3	81.7	81.0	81
748	85.3	84.9	84.6	84.2	83.8	83.4	83.1	82.1	82.0	81 7	81.4	81.1	80
749	85.0	84.0	84.3	83.9	83.2	82.8	82.5	82 1	81.7	81.4	81.1	80.8	80

Hydro-Cy is delivered to the field in drums holding 100 lbs. of liquid and the contents of each drum are certified before leaving the factory. Inas-much as the density of the pure liquid is less than three-fourths that of water and the principal impurity which is to be encountered in Hydro-Cy is water, the determination of the specific gravity may be used as a criterion of the purity of the liquid. In checking and certifying Hydro-Cy

use is made of the specific gravity determination. The specific gravity of the liquid changes with varying temperatures and therefore the temperature of the liquid undergoing test must be noted simultaneously with the hydrometer spindle reading.

As a means of quickly determining the percentage purity of the liquid by the specific gravity reading, the above density tables have been carefully prepared and checked in our laboratory. In assembling the data for the tables certified hydrometers and thermometers (U. S. Bureau of Standards) were used . In using the tables the specific gravity and temperature of the liquid under test are noted and the corresponding percentage purity is determined by referring to the tables. It requires no great technical skill to make such observations, but care must be exercised in using only the best grade of hydrometer spindles and thermometers and in drawing and confining the sample of liquid during the test.

Tested

The uniform purity of Hydro-Cy is indicated in the following table of official tests made on samples taken in the field by representatives of the Division of Chemistry of the Department of Agriculture of the State of California.

Official Examination of Hydro-Cy

1		HYDRO	CYANIC	ACID.	-	~	2	
)	Liquid	Prussic /	Acid.				7
1	This tion at State I has atta VIII, h to or ov	extensively used form of the Insecticide Laborato Division of Chemistry, the ained such uniformity of below, being obtained upon ver their guaranteed perce	cyanide ory, Uni at no oth composit on official entage of	compo versity ler ecc tion. I samp hydro	ound si y of (onomic The r oles, a ocyani	howed Califo e pois esults ll of ic acid	l by ex rnia a on yet in the which l:	amina- nd the tested Table are up
4		TABLE VI	II. PRUSSIC Liquid.	ACID.				5
Į	Laboratory number	Name of brand, manufacturer, agent and sender	Guaranteed and found	Degrees Baume*	Temp. F.°	Active ingredi- ent, hydro- cyanic acid, per cent	Inert, per cent	Opinion cf sample
1	Lab. 240 Lab. 241	Hydro-Cy Prussie Acid, Pacific R. and H. Chemical Company, Dales and Gregg, Riverside. Hydro-Cy Prussie Acid, Pacific R. and H. Chemical Company Dales and H. Chemical Company Dales and Acid.	Guaranteed. Found	69.0	68	96-98 96.0		Passed.
(Lab. 242	Gregg, Riverside. Hydro-Cv Prussic Acid, Pacific R. and H. Chemical Company, Anaheim Orange and Lemon Association, Anaheim	Guaranteed	69.5	70	96.6		Passed.
2	Lab. 244	heim. Hydro-Cy Prussic Acid, Pacific R. and H. Chemical Company, Anaheim Cit-	Found	68.5	62	97,3		Passed.
1	Lab. 1155	rus Fruit Association, Anaheim Hydro-Prussic Acid, Morage and Wood- head, Whittier, Pacific R. and H.	Found Guaranteed	67 5	58	97.1		Passed.
l	Lab. 1156	Hydro-Cy Prussic Acid, Pacific R. and H. Chemical Company, Morago and	Found Guaranteed	68.0	62	96.8		Passed.
	Lab. 1158	Woodhead, Whittier Hydro-Cy Prussic Acid, Pacific R. and H. Chemical Company, Morago and	Found Guaranteed	67.5	60	96.6		Passed.
)	Lab. 1178	Woodnead, Whittier Hydro-Cy Prussic Acid, Pacific R. and H. Chemical Company, Howley and	Found Guaranteed	68.5	63	97.1	4.9	Passed.
1	Lab. 1179	Brock, Orange_ Hydro-Cy Prussic Acid, Pacific R. and H. Chemical Company, Geo. Howley.	Found Guaranteed	67.0	53	97.7	4-2	Passed.
2	Lab. 1181	Santa Ana. Hydro-Cy Prussic Acid, Pacific R. and H Chemical Company, Orchard Oper-	Found Guaranteed	67 5	59	96.9		Passed.

Reproduction from Special Publication No. 34, Department of Agriculture, State of California, p. 24.

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Handling & Storing of Hydro-Cy

Because of the high volatility of Hvdro-Cy and the fact that it is an exceedingly poisonous compound, as well as being inflammable, more than the ordinary precautions must be taken in handling it and storing it in places of safety where only authorized persons may have access to it.

Hydro-Cy is packed and shipped in containers holding 100 lbs. net. The containers shown in the photograph on page 13, are constructed of materials which are not readily attacked by the action of the liquid or gas. They are not in any sense pressure containers and therefore will rupture under high internal pressures. To eliminate the danger of rupturing containers each one is equipped with a specially designed relief valve which is adjusted so as to release the gas gradually from the drum when a given pressure has been reached. The pressure at which these valves begin to operate is approximately 7 lbs. per square inch. Hydro-Cy drums are built to withstand an internal pressure of about 20 lbs. With the proper handling and storing of the liquid in the field pressures sufficient to operate the relief valves are not developed. The relief valve is just a safety sentinel which acts quickly, positively and automatically when occasion demands.

Hydro-Cy containers, upon return from the field, are thoroughly washed. cleaned, inspected and tested for tightness, by means of air pressure, before repacking and reshipping. The operation insures cleanliness and reduces the danger of damaged containers being recharged with the poisonous liquid.

It is physically impossible for the manufacturer to guarantee that containers will not develop leaks after delivery to the field. We use every precaution to see that defective containers are not recharged. We advise our customers to refrain from storing the liquid in the shade of citrus trees since the spilling of the liquid about the roots of the tree may result in its death.



Hydro-Cy should be stored in the field in places which are accessible only to authorized persons.

Drums containing Hydro-Cy should not be left in the field exposed to the direct sunlight unless adequate provision is made to keep the liquid cool. It is preferable, whenever possible, to return the drums and applicators each day to the central warehouse where the liquid can be kept under lock and key and better facilities are obtainable for keeping it cool.

Hydro-Cy can be maintained at sufficiently low temperatures, under ordinary circumstances, by storing the drums in the shade and surrounding

Containers

Storage Emplacements for Hydro-Cy

them with canvas or sacking kept continuously moist. The success of this method of storage depends on providing free circulation of air about the drums and not allowing the sacking to become dry.

Insulating materials may be effectively used in maintaining the liquid at low temperatures. In this method the drums of liquid must be covered with the insulating jackets when the liquid is cool.

Our company has used with marked success the underground system of storage in which drums of Hydro-Cy are stored in individual compartments or cells placed in the ground. By protecting the underground emplacement from the direct sunlight Hydro-Cy may be stored and maintained at temperatures several degrees below its boiling point during the warmest days of the summer. This system insures storage under conditions of maximum safety with the minimum of fire risk because every drum is stored in an individual cell. On the preceding page is shown a view of part of the storage emplacement, showing the tiles buried in the ground and the drums setting in the tile, protected on the top with a heavy wooden cover. Such a system can be inexpensively constructed and occupies but small ground space.



Fleet of R & H Trucks, Loaded With Hydro-Cy, Starting Day's Delivery

Transportation of Hydro-Cy

We maintain our own fleet of motor trucks for the sole purpose of making quick delivery of Hydro-Cy and fumigating supplies direct to the orchards throughout Southern California. Our trucks are equipped with special bodies to provide safe delivery of Hydro-Cy and we take pride in the standard of service rendered. We realize the importance of the fumigator receiving his shipment of Hydro-Cy at the time desired and our determination is to maintain the highest standard of delivery service possible to obtain.

Hydro-Cy is delivered in safety drums, each containing 100 lbs. of liquid, and each drum bears an identification number. We certify to the degree of purity of each individual shipment.

In order to insure the delivery and maintain Hydro-Cy during transportation in safe condition as to temperature, each drum is heavily iced.

A Few Hints and Precautions

Hydrocyanic acid gas is rapidly given off from the surface of the liquid when it is exposed and therefore the person handling it should use great caution and refrain from breathing in an atmosphere close to an open container. More gas is released as the surface of the liquid is increased and also with rise of temperature. It is important, therefore, that the liquid never be sprayed or spattered when handled in the open. Should there be any accidental spilling of the liquid the operator will be reasonably safe by keeping to the windward side of the exposed liquid.

Do not inhale in an atmosphere highly charged with hydrocyanic acid gas, but turn away and get into the fresh air before inhaling again. Do not open drums before first venting the gases. This can be done

Do not open drums before first venting the gases. This can be done by lifting the relief valve cautiously. Unscrew the drum plug cautiously, venting the drum again just before lifting out the plug.

Keep all open flames away from places of storage and exposed drums of liquid, applicators, etc.

Store Hydro-Cy under lock and key, in places of safety where it is accessible only to authorized persons.

Do not attempt to store Hydro-Cy for long periods of time or carry it from one season to another. Ask to have the liquid left over at the end of a season returned promptly.

Do not pour Hydro-Cy from one container to another or from a container to an applicator in a manner similar to pouring water from a pitcher. Always use the devices provided for transferring the liquid from one container to another and have both containers mounted on a rigid support. During the process of transferring the liquid the operator should stand off a safe distance on the windward side of the apparatus and in such a position that he can have full view of the operation.

Do not transport Hydro-Cy in shipping drums placed on the running boards of motor vehicles. This practice is exceedingly dangerous to the public using the highways.

Always have two men present in any operation involving the transportation and handling of Hydro-Cy.



Hydro-Cy Drum Showing Safety Value

Keep Hydro-Cy as cool as possible—the colder you keep it the less danger there is to those handling it.



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Method of Filling Pump from Drum 13

Applying Hydro-Cy

In the application of Hydro-Cy to citrus tree fumigation, two methods, using two different types of apparatus, are employed; namely, the "atomizing" method using the Hydro-Cy Pump; and the "vaporizing" method, using the Hydro-Cy Vaporizer.

In the use of Hydro-Cy as a means of getting gaseous hydrocyanic acid under the tent there are two problems of fundamental importance. The first is that of correct measurement of the liquid and the second that of securing conversion of the liquid into a uniformly distributed gas or vapor under the tent. All appliances, therefore, for the application of Hydro-Cy must embody an accurate measuring unit. In the types of appliances employed one type mechanically converts the liquid into a warm gas, while the other introduces the liquid under the tent as a finely divided spray.

"Vaporizing" Method

In this method of application, Hydro-Cy is converted into a warm gas outside the tent and subsequently introduced into the tented enclosure through a hose. In this method a complete charge of liquid is quickly converted into a warm gas and quickly introduced under the tent where it is uniformly distributed in the minimum of time and before the leakage of gas from the tent becomes appreciable.

This method is especially adaptable to Fall and Winter fumigation when the temperature during the evening ranges below 50°F. as it provides positive assurance that every ounce of liquid measured is converted into a warm gas. The method is equally effective at higher temperatures and therefore can be used with safety and assurance of satisfactory results throughout the entire fumigating season.

As a result of our own extensive experiments we are convinced that a given weight of Hydro-Cy will give, when vaporized and quickly distributed under the tent, an average of 10 to 15% higher initial gas concentration than when introduced by the "atomizing" method as a mist or spray.

A warm gas quickly and uniformly distributed means added insurance to the grower and fumigator for effective and efficient fumigation.

"Atomizing" Method

In the "atomizing" method a cold spray of Hydro-Cy is introduced under the tent whence the liquid by evaporation is converted into a gas or vapor and by the process of diffusion is distributed to different parts of the tented enclosure. For the application of the liquid hand spray pumps or applicators are used. These appliances have as an integral part of their discharge end an atomizer or spray nozzle for breaking the liquid up into a finely divided spray. In this process, the finer the atomization of the liquid, the greater is the surface of liquid exposed resulting in a corresponding increase in rate of evaporation and hence more effective fumigation.

The "atomizing" method is the simplest and most convenient of all methods of fumigation. On account of its great convenience it has been used throughout the citrus belt of California.

The Hydro-Cy Vaporizer

The Hydro-Cy Vaporizer is a horse drawn machine for converting Hydro-Cy into a warm gas and subsequently discharging the gas under the tent. The vaporizer is designed and constructed to provide easy portability in the orchard and embodies the utmost in safety, simplicity and accuracy. The machine, a photograph of which is shown below, comprises a chassis with Ford solid rubber tired wheels, on which is mounted an original 100 lb. drum of Hydro-Cy; a safe, simple and accurate measuring mechanism; and a safe, simple and positive vaporizing unit. The measuring unit employed is similar to that used on the Hydro-Cy pump measuring with dependable accuracy given charges or dosages of liquid in units of five



Hydro-Cy Vaporizer in Action

and one respectively. The vaporizing unit consists of a coil submerged in hot water, the water being heated by means of a gasoline burner. The burner is securely enclosed in a chamber wherein all openings are protected with wire mesh gauze preventing flames and explosive waves from escaping and assuring positive protection to the apparatus from danger of fires and explosions. The liquid to be vaporized is discharged from the measuring unit directly into the coil of the vaporizing unit, whence it is then instantaneously converted into a warm gas and transferred to the tent through a

The Warm Gas Method



Hydro-Cy Vaporizer

hose. The machine is transported through the orchard by means of a horse. It weighs 625 lbs., fully equipped with a 100 lb. drum of Hydro-Cy mounted in position. The span of the wheels measured from the center of the hub is 42 inches; the overall height is 50 inches. The narrow span, wheels of small diameter, and the fact that the machine sets near the ground, means that it can be operated in orchards which are interplanted without danger of pulling fruit or otherwise injuring the trees.

The time required to get the machine ready for operation at the start of each night's work is about twenty minutes. This time is devoted to generating the gasoline burner, heating the water and hitching the horse to the machine.

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Advantages of Hydro-Cy Vaporizer

1. The vaporizer converts Hydro-Cy into a warm gas, thereby insuring complete vaporization of every ounce of liquid measured.

2. The mechanical conversion of the liquid into a warm gas has the advantage that a complete charge as a gas can be discharged into the tent in the shortest time possible, assuring quick diffusion and uniform distribution of the gas before an appreciable quantity of it can escape from the tent.

3. Applying a warm gas lessens the danger of damage to young trees, fruit or foliage by eliminating any contact of the liquid with the tree.

4. The use of warm gas permits satisfactory and effective fumigation work at lower temperatures than is possible with the cold gas method. Crews operating during the cooler months are able to average several hours more working time per night than crews operating the hand spray pumps. This fact gives added insurance against the loss of time.

5. Every tree is uniformly treated, a great advantage over the pot and portable generator methods. The last tree in the row receives exactly the same treatment with respect to accurately measured dosage and temperature of gas as every other tree in the row receives.

6. Greater safety is provided in handling Hydro-Cy. A full drum of liquid is placed in position on the machine and does not have to be touched again until empty. This avoids the necessity of transferring the liquid from a drum to an applicator tank at the end of every throw.

7. As compared to the pot or portable generator method of fumigation, the vaporizer method is far more convenient. There are no cyanide or acid solutions to handle and no residue to dispose of.

8. The heavy work of pulling the machine through the orchard is done by a horse.

9. The vaporizer is designed to handle work for orchards of any acreage and for large and small trees. It vaporizes Hydro-Cy at the rate of one pound (36-18 cc. units) per minute or between 60 and 70 pounds per hour.

During the season of 1921 and 1922, the vaporizer was thoroughly tested on a commercial scale in all the citrus districts of Southern California. Its utility for commercial work has been completely demonstrated to the satisfaction of horticulturists, growers and fumigators.

Fumigators or associations who have used the Hydro-Cy Vaporizer are unanimous in reporting the absence of burning to fruit and foliage. This fact in itself deserves serious consideration on the part of growers or fumigators in districts where burning is a factor to be contended with.

Operators have experienced no mechanical difficulties and find the machine easy and simple to operate.

are pending.

The Hydro-Cy Vaporizer is covered by our basic U. S. Letters Patent No. 1,336,822, dated April 13, 1920, and various patent applications which



Hydro-Cy Pump in Action **The Hydro-Cy Pump** The Cold "Gas" Method

The Hydro-Cy Pump, cuts of which are shown on these pages, employs the principle of atomization and introduces the liquid under the tent in a finely divided spray. The pump simplifies the art of fumigation, provides the maximum of safety to the operator, represents about the last word in convenience, and its construction is almost indestructible.

The pump is made up of the following main parts: a tank for holding the liquid; a measuring unit, consisting of a piston moving in a cylinder; and means for discharging the measured quantity of liquid through an "atomizing" nozzle.

The pump weighs about 18 lbs. empty and is designed to be carried conveniently by hand. Pumps are equipped with tanks holding approximately 3 gallons (17 lbs.) or 4 gallons (21 lbs.) of liquid. The 3 gallon tank will carry enough liquid to fumigate sixty 10 ounce trees using the 100% (18 cc.) schedule; the 4 gallon tank on the same basis will furnish enough liquid for 75 10-ounce trees or 60 12-ounce trees.

The measuring unit employs no finger plate and the dosage does not have to be set for each tree. In operating the pump the number of full strokes determines the charge; one long stroke delivers 5 units and by turning the handle slightly one short stroke, delivering a one unit charge, is made. For this reason the machine can be operated in pitch darkness.

The accuracy of the Hydro-Cy Pump can be determined and proved at any time by discharging liquid from the nozzle into a graduated cylinder, or more preferably by employing a graduated device shown in the photograph on page 21. These devices will be supplied at cost upon request. Every service man in our organization carries these calibrating devices and all machines distributed by us are checked and tested periodically.

The Hydro-Cy Pump embodies many safety features. For example, no materials of a breakable nature such as gauge glasses are employed. A float is used for determining the level of the liquid in the tank. There are no troublesome stuffing boxes below the liquid level and this feature, together with the fact that only the liquid which is being discharged through the nozzle is ever under pressure, combines to make



the pump positively *leak* proof.

The Hydro-Cy Pump has been in commercial use for two full seasons, during which time it has thoroughly demonstrated its superiority over all other appliances of the atomizing type. The pump embodies many exclusive advantages.

Hydro-Cy Pump 19



1. Lightness and Portability. Can be conveniently "spotted" at any Point.

- Simple design requiring no intricate adjustments. 2.
- 3. Substantially constructed of only the best materials.
- 4. Accuracy of the measuring unit assuring accurate measurement.
- 5. Can be operated in the dark without fear of miscalculated dosage.
- 6. It is unnecessary to transport water, fuel or cumbersome equipment.
- 7. There is no residue to dispose of.

Unit

- 8. No mixing of solutions are required. Simply fill the tank with-Hydro-Cy and the pump is ready to operate.
- 9. Can be operated successfully in warm temperatures ranging as high as 75° and in some instances 80 and 85° F.
- 10. Tents are not damaged as Hydro-Cy has no injurious effect.
- 11. More rapid work is permitted and less labor required.
- 12. No initial expense in equipment is involved.
- 13. Its DEPENDABILITY is revealed by the unqualified endorsements of hundreds of satisfied users.

R & H

In order to facilitate the work of fumigation, dosage tables for use with liquid hydrocyanic acid have been prepared by Mr. R. S. Woglum, which for different sized trees give the exact dosage required. These tables are based on the data experimentally obtained. In compiling the tables the leakage of gas through the tent material and many other factors encountered in fumigation practice have been taken into account.

The standard dosage table from which all dosages are calculated is known as the 100% table, the unit of dosage being 18 cubic centimeters of liquid. This table is given on page 23.

In the field one hears very frequently the term "ounces" used in connection with the dosages of liquid hydrocyanic acid. This term is one which has been carried over from the old days of pot and portable generator methods of fumigation when solid cyanide was in general use. In the 100% or standard schedule 18 cc. (one unit) is equivalent to one ounce of solid cyanide. That is, under actual field conditions the same amount of gas (HCN) is obtained from 18 cc. of liquid as is obtained from one ounce of



Calibrating Gauge Mounted on Applicator

Dosage Tables

solid cyanide. Therefore, the term "ounces" when used in connection with liquid HCN means units and a tree calling for a dosage of 12 ounces on the 100% schedule means 12 units or (12x18 cc.) 216 cc. of liquid.

Dosage schedules other than the 100% schedule are very frequently used. The schedules in more common use are the 77%, 88%, 110% and 122%. The time of year, the species of scale and the condition of the tree are factors having to do with the determination of the schedule which should be used.

Calculating the Dosage

The dosages required are determined from the table by measuring the circumference of the tent when over the tree and the distance over the tent from the ground line on one side to the ground line on the opposite side. To facilitate the taking of measurements of the distances over the tent, tents are marked according to the Morrill system. In this system three parallel lines and one line at right angles to them are indicated on the tent. The middle one of the three parallel lines passes through the central point in the tent canvas running lengthwise of the central section or strip of which the tent is made and passing over the top of the tent from one edge of one side to the edge on the other side; these lines also run in the direction in which the tent should be pulled on or off the tree. Beginning at the center the lines are graduated in feet toward the edge of the tent. With one of the lines over the middle of the tree the distance over is calculated by adding together the two numbers on the opposite sides of the tent where the edge touches the ground. For instance, suppose that on the line over the center of the tree 12 is nearest the ground on one side and 15 on the other. The distance over the center of the tree would be the sum of these numbers, which is 27 ft. With the lines graduated after this manner it makes little difference in determining the distance over the top of the tree whether or not the geometrical center of the tent is at the center of the tree, the single requirement being that some part of one of the graduated lines approximates the center of the tree. Having determined the distance around and the distance over the tree, reference is then made to the dosage table and the required dosage determined. For example, a tree measuring 36 ft. over and 48 ft. around calls for a dosage of 16 units.

In operating with a 88% schedule, for example, the same dosage table is used but the dosage or actual amount of liquid measured is compensated for on the appliance. Thus, the measuring unit on both the Hydro-Cy Pump and the Hydro-Cy Vaporizer is equipped with a schedule or dosage rack by which the unit of dosage can be changed at the will of the operator.

The term "14 cc. schedule" or "22 cc. schedule" is often used to express the dosage and the following table gives the relationship between the different terms applied to the dosage schedule and the number of units in one pound of Hydro-Cy.

Schedule	Cubic Centimeters	No. of units
Percent	of liquid in 1 unit	in 1 lb. of Hydro-Cy
77%	14 cc.	46.0
88%	16	40.4
100%	18	36.0
110%	20	- 32.4 -
122%	22 +	29.5
133%	24	27.0
	22	

							T	HE	P	AC
GRO	VE			12						-
DAT	E						F	DRE	MA	N
Set	Time	Tem.	Hum.	1	2	3	4	5	6	7
1										
2										
3					1					
4										
5										
6										
7		0		1.						
8										
9										
10				1						
Set	32	33	34	35	36	37	38	39	40	41
1										
2		-								
3								-		
4										
5										
6										
7										
8	-									
9										
10		1						-		

In order to have a record of the fumigation work done on a grove it is advisable for the fumigation foreman to keep a chart of each orchard showing the dosage given each tree, the schedule used, the kind of scale and the different conditions such as temperature, humidity and time under which the work is carried out. To facilitate the keeping of these records and as a part of our service, charts are supplied to all users of Hydro-Cy and Hydro-Cy appliances.

FOR CITRUS TREE FUMIGATION WITH "HYDRO-CY" (96-98 PER CENT HYDROCYANIC ACID)

	20	22	24	26	28	30	32	34	36	38	40	42	44	46	48		50	52	54	56	58	60	62	64	66	68	70	72	74	76	78	
20	5	5	6	6	6	6	6	7	7	7	7	7				50	25	26	27	28	30	30	31	32	33	34	35	36	36	37	38	5
22	5	6	6	6	6	7	7	7	7	7	7	7	8	8		52				30	31	32	33	34	35	36	37	38	38	39	40	5
24	6	6	6	6	.7	7	7	7	8	8	8	8	9	9		54					32	33	35	36	37	38	39	40	40	41	42	5
26				7	7	7	7	8	8	9	9	9	10	10	10	56				-		35	36	38	39	40	41	42	42	43	44	5
28					7	7	8	8	9	9	10	10	11	11	11	58						36	38	39	40	41	42	43	44	45	47	5
	20	22	24	26	28	30	32	34	36	38	40	42	44	46	48		50	52	54	56	58	60	62	64	66	68	70	72	74	76	78	
30						8	8	9	10	10	11	11	12	12	12	30	13	13	14	14	14											3
32			-	1	-		9	10	10	11	12	12	13	13	14	32	14	15	15	15	16	16									_	3
34								10	11	12	13	13	14	14	15	34	15	16	17	17	17	18	18	18						-		3
36		_			-		-	11	12	13	14	14	15	15	16	36	17	17	18	18	19	19	20	20	21							3
38		_							13	14	14	15	16	17	17	38	18	18	19	20	20	21	21	22	22	23						3
	14	16	18	20	22	24	26	28	30	32	40	42	44	46	48		50	52	54	56	58	60	62	64	66	68	70	72	74	76	78	
10	2	3	3	3								16	17	18	18	40	19	20	21	21	22	22	23	24	24	25	25					41
12	3	3	4	4	4	4	-						18	19	20	42	21	21	22	23	23	24	25	25	26	26	27	28				43
14	3	4	4	4	4	5	5							20	21	44	22	23	23	24	25	26	27	27	28	28	29	30	30			44
16	4	4	4	5	5	5	5	5	5							46	23	24	25	26	27	27	28	29	29	30	31	32	32	33		40
18	4	4	5	5	5	5	5	6	6	6						48	24	25	26	27	28	29	30	31	31	32	33	34	34	35	36	48
1	14	16	18	20	22	24	26	28	30	32	40	42	44	46	48		50	52	54	56	58	60	62	64	66	68	70	72	74	76	78	-

Unit of Dosage 18cc



Dosage Charts

DOSAGE	SCHEDULE

Prepared by R. S. Woglum, Entomologist

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Species of Scale Insects

The insects most injurious to citrus trees in California and elsewhere belong to the family of coccidae, known more generally as scale insects. The most abundant and most injurious of these are the white scale, red scale, black scale, purple scale, citricola scale and the citrus mealy bug, of which the red, black, purple and citricola are the most abundant. For particulars regarding the life history and habits of these different insects, the reader is referred to the many publications of the U.S. Department of Agriculture and bulletins of the various agricultural experiment stations and of the University of California.

When to Fumigate and the Schedule Which Should Be Used*

Black Scale. Should be fumigated when in the youngest stage of development. The season extends from August to December, some coastwise orchards being excepted. An 85 to 100% dosage for one hour is advised. Very resistant type scale requires even more concentrated gas dosage. If double fumigation is required, the second treatment should follow the first by two or three months.

Red Scale. From the middle of December to April is the preferred season to fumigate for resistant red scale. A 122% schedule is frequently used on lemon, 100 to 110% on oranges. The ordinary red scale can be fumigated at any time of the year with 85 to 100% schedule. The exposure should be from 45 minutes to one hour.

Citricola Scale. Fumigation during July and August with 100% schedule is recommended; during the first part of September use 110% schedule if possible. Do not fumigate later than the middle of September.

Purple Scale. If possible for the trees to stand it, use 100% schedule and never less than 88%. Exposure should be one hour. Ineffective control is likely to follow work done with less than 88% schedule, especially if infestation is severe. Fumigation for purple scale during the winter is not recommended.

Fumigating Season

The time to fumigate depends upon the stage of development of the scale and the condition of the trees. There are certain periods in the year when the fruit is in tender condition and cannot withstand the heavy dosage that is sometimes required. Fruit is of small and tender size during the period extending from April to mid-summer. There is less likelihood of damage to the trees when fumigation is carried on during the blooming season or when the fruit is advanced in growth.

Fumigation is carried on during almost all times of the year but the greatest safety is provided when fumigation takes place from August to January, providing, of course, that attention is given to the meteorological conditions. Most of the restrictions apply to orange and grape-fruit trees; lemons may be safely fumigated at all times of the year.

Fumigation can be safely undertaken at temperatures below 75°F. and not lower than 37°F.; as a rule temperatures ranging between 50 and 70°F. are preferable.

In the coastwise districts it is generally unsafe to fumigate above 75°F.; in the hot interior districts fumigation has been carried on with safety at temperatures as high as 80°F. and even 85°F.

* Recommendations of Mr. R. S. Woglum, Entomologist, California Fruit Growers' Exchange.

Authorized Regulations Governing Fumigation

The following requirements and recommendations have been compiled under the direction of Horticultural Commissioners H. J. Ryan of Los Angeles County, A. A. Brock of Orange County, J. P. Coy of San Bernardino County, A. E. Bottel of Riverside County, collaborating with R. S. Woglum, entomologist, and Inspector K. L. Wolff of Los Angeles. These requirements were in force during the season of 1922.

1. All fumigating tents shall be marked in accordance with the Morrill system.

in use.

4. No pump for liquid gas application shall be operated having more than 3% variation from correct measurement.

5. Each tent shall be placed so that one line of numerals runs over the center of the top of the tree.

6. Tents shall be kicked in to hang perpendicular from the outer limbs of the tree to the ground and shall touch the ground on all sides.

7. Work must not be carried on when wind is strong enough to cause any appreciable movement of the tent.

8. Each tree requiring more than a 4 unit charge shall be taped and correct dosages, as called for upon the chart, given.

the temperature is below 37°F.

ture is below 50°F.

13. Deviation EXCEPT BY GROWER'S CONSENT from any of the foregoing requirements will be considered sufficient grounds for the revocation of the crew foreman's license or contractor's license or certificate to operate.

14. Each fumigator shall submit on the first of each month a report to the County Horticultural Commissioner showing for each piece of work performed during the previous month date, grower's name, location of orchard, number of orange or lemon trees, kind of material used and strength. 15. Fumigators shall keep on file and furnish upon request of horti-

cultural commissioner a statement of the amount of material used on any piece of work.

16. A chart of each orchard shall be made and kept on file for one year showing the dosage given each tree and the temperature and time at the beginning of each set. A copy of this chart shall be furnished the grower by County Horticultural Commissioners upon request.

17. Carelessness in the application of materials or other evidences of abuse of privilege to do business under license or certificate shall at all times constitute grounds for revocation of same.

2. The foreman of each fumigating crew shall be equipped with a thermometer, properly tested, within the range of 28 to 100°F.

3. All equipment used by fumigators shall be kept in good repair when

9. Trees shall be given not less than 45 minutes exposure regardless of dosage and the work of tent pullers shall be regulated accordingly.

10. Trees shall not be fumigated with pots or portable generators when recoldgas.

11. Trees shall not be fumigated with liquid gas, when the tempera-

12. Work shall be discontinued when tents begin to become damp.

Aids to Successful Fumigation*

1. Tape trees; do not guess at measurements and dose according to schedule.

2. Employ the best labor obtainable... A careful and experienced foreman is the keynote to safe, effective fumigation.

3. Avoid fumigation during even a moderate wind as results are liable to be poor.

4. Avoid fumigating orchards heavy in cover crops.

5. Use heavy dosages, starting with 85% schedule if possible and increasing to 100% as soon as the trees will stand the heavier dosage.

6. Inspect and test appliances frequently, at least two or three times a week.

Precautions to Avoid Tree Injury

1. Avoid fumigating trees sprayed with Bordeau mixture or painted with Bordeau paste high above the trunk within ten months after application.

2. Avoid fumigating at too low temperatures. Fumigation with pot or portable generator should be stopped at 36°F. on damp nights and on dry nights when the first warnings indicate that the temperature is likely to fall to freezing or below.

3. Avoid fumigating with wet tents.

4. Avoid fumigating in the bright sunlight. Safe sunlight fumigation requires a proper knowledge of dosage, exposure and temperature influences. Without this knowledge daylight fumigation should not be attempted.

5. Avoid fumigation during periods of desert or "electric winds."

6. Fumigation should precede rather than follow an irrigation.

7. Avoid directing the nozzle of applicators against the trunks of small trees.

8. Avoid dumping the residue from pots or cyanofumers near the trunks or roots of trees.

9. Avoid storing liquid hydrocyanic acid under citrus trees.

Equipment **Tent Material**

The question of proper tent material is a very important one because if improper or defective material is used unsatisfactory results and failures in fumigation work will doubtless result frequently. Experiments have shown that the most suitable material so far obtainable is $6\frac{1}{2}$ oz. drill for the smaller sized tents and 8 oz. double filled duck for the larger sizes. The factors to be considered in the purchase of tents are durability, tightness and weight. While the durability will naturally increase with the weight of the tent material there is a limit to the weight as in the first place too heavy tents will injure the trees and, secondly, the covering with tents even of the smaller sizes cannot be done by hand. With the material above recommended, i. e., 8 oz. duck and $6\frac{1}{2}$ oz. drill, tents of small and medium sizes can be placed over trees quickly and satisfactorily by hand, while for larger sizes derricks are used. The durability of 61/2 oz. drill and 8 oz. duck has been found sufficiently satisfactory to insure a life of from three to four years per tent, provided of course that tents are properly cared for.

The most important factor in the consideration of tent material is the tightness, because if the tents are not reasonably tight the leakage of gas through the material prevents the application of the proper dosage to the * Excerpts from address by Mr. R. S. Woglum before Pest Control School held at Pomona, July 15, 1922.



trees which results in failures as to the killing of insects. Neither drill nor duck are absolutely gas tight but by using the best grades of these materials available and using dosages sufficiently high to allow for certain leakage of gas, this deficiency will be somewhat overcome. Attempts have been made to make tent material absolutely gas tight by treating it with different substances, but such treatment either results in a considerable increase in weight or it makes the material stiff, both of which considerations should be avoided. Gas tight tents made from balloon fabrics and also by treating canvas or drill with rubberizing compounds have been experimented with but the initial cost and the heavy depreciation precludes any serious consideration of tents made from rubber fabrics or treated in the above manner.

The sizes of tents in use in California and elsewhere are 24', 30', 36', 41', 45', 48', 56', and 84' tents, of which the 36 to 45 sizes are the most common. Tents are octagonal in shape and are constructed and marked according to the Woglum and Morrill system. For details pertaining to the construction and the marking of tents, the reader is referred to Bulletin No. 90 of the U. S. Department of Agriculture, entitled "Fumigation of Citrus Trees" by R. S. Woglum.

The table below gives the amount of cloth for the different sized tents. The calculations are based on cloth 30" wide and represent the number of lineal yards of such cloth required,-not square yards. Allowance of an inch to each strip has been made for overlapping edges. These figures are based on the assumption that the cloth is cut without waste.

Cloth Size of Tent (30 in

24	fee
30	"
36	>>
41	. ??
43	"
45	22

Method of Pulling Canvas Tent Over Tree

required ches wide)	Size of Tent	(30 inches wide)
Zards		Yards
70	48 feet	265
105	52 "	310
105	55 "	345
105	64 "	470
195	72 "	590
235		
433		

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Poles and Derricks

Poles and uprights are used for raising the front edge of the fumigating tents when covering a tree or pulling the tent from one tree to the next in the adjoining row. Straight grained Oregon Pine or seasoned cypress 2" in diameter are used for poles not exceeding 18 ft. in length; for poles longer than 18 ft. diameter should be $2\frac{1}{2}$ ". It is well to have several pairs of extra poles on hand as a provision against breakage. A 1/2" rope of either manila or cotton about $1\frac{1}{2}$ times the length of the poles is attached about 3 or 4" from the top of each one. The top of the pole is so rounded that it allows the ring to slip over the end for a distance of $1\frac{1}{2}$ to 2". The lower end of the poles should be pointed to prevent its slipping on the ground when the tent is being lifted.

For use with sheet tents which are too large for convenient handling with the poles described, a pair of uprights or derricks is needed. These are somewhat heavier poles with braced crosspieces at the bottom to prevent them from falling sidewise when in an upright position and each is provided with a pulley at the top. The poles are 25 ft. or more in length, from 3 to 4" in diameter at the top. They may be made of straight grained knotless pine or seasoned cypress. Wherever the latter can be obtained it is preferable to pine on account of its lightness. The details in the construction of derricks will be furnished on application.

Tapes

Special tapes marked with the Woglum dosage schedule are manufactured and sold by the Fruit Growers' Supply Co. Arrangements can be made through our company for the purchase of these tapes. The tapes are made in the following lengths and the approximate cost of each is given. 50

tt.	\$3.50	66 ft.	\$3.90	76 ft.	\$4.25

Thermometers

Certified armored thermometers are required. These instruments can be purchased through us or direct from the local laboratory supply houses. \$3.00

Thermometer without case Thermometer with case

\$6.00 The U. S. Bureau of Standards, Washington, D. C. and the Department of Meteorology of the Los Angeles Chamber of Commerce, 800 Central Bldg., are properly equipped to test thermometers. The seal and certificate of either of these offices will be accepted. A nominal fee is charged for this service.

Transferring Devices

Devices for transferring the liquid from the shipping drums to applicator tanks are loaned free of charge to users of Hydro-Cy and Hydro-Cy appliances.

Schedule Holders

Convenient holders for the dosage tables and dosage record charts are provided without cost and constitute a part of R & H service. Dosage charts are supplied with each order for appliances and additional charts can be obtained upon request.

Service

As a part of our service we are glad to make arrangements for the purchase of any supplies needed by the fumigator.

Fumigation Vs. Spraying

Whether to spray or fumigate for scale control is a much mooted question with some growers and an intelligent answer to this question involves a thorough knowledge of existing conditions. Where a grove is infested with scale, the grower can ill afford not to consult with his local horticultural inspector or Commissioner for advice as to the proper method of control to use. In the majority of cases the grower has only one choice for if his grove is moderately or severely infested with scale, fumigation is the only method which he can afford to employ.

Spraying is fundamentally a mechanical or physical process of applying insecticide materials and its success is largely a matter of the personal equation. On the other hand, fumigation is a chemical process, whereby the atmosphere is charged with gaseous hydrocyanic acid that permeates to every part of the tree. Not a single leaf or twig can escape coming in contact with the poisonous gas, whereas in spraying it is almost a physical impossibility to wet every part of the tree.

Horticulturists and entomologists concede the superiority of fumigation with hydrocyanic acid gas as the most efficient and effective method of scale control and they have reached this conclusion as the result of years of experience with the different methods and the different sprays which have been employed. To emphasize the necessity and superiority of fumigation we quote direct statements from several of these authorities.

Mr. R. S. Woglum, Entomologist, California Fruit Growers Exchange: "Fumigation with hydrocyanic acid has long been considered the fore-

most insecticide for the control of scale insects on citrus trees in California. Its general superiority over all other methods has established the gas process as the standard of efficiency to which all other citrus scalecides are compared for classification. In common with other insect control measures fumigation has had its failures but these failures have been far fewer in proportion to its extensive use than for any other scale remedy in this State up to the present time."

In an address before the Central California Citrus Institute held at Lindsay, Calif., September 6, 1922, Mr. Woglum stated:

'Where the problem is scale control and that alone, my observation and experience leads me to unhesitatingly recommend fumigation. I have lived through the eras of many sprays, but have yet to see the spray that will average in effectiveness in scale kill, under general commercial conditions, properly timed and properly conducted fumigations."

Horticultural Commissioner H. J. Ryan of Los Angeles is authority for the statement that once a grove becomes badly infested it is difficult to clean it up and he declares that a 45% deterioration takes place in groves neither fumigated or sprayed for one year, but he adds that the pest is easily kept in control if fumigated annually.

Mr. Ryan has for three years compiled the results of the different insecticide methods used for scale control in Los Angeles County and these data show conclusively that fumigation is by far the most certain method for controlling scale insects.

Horticultural Commissioner F. R. Brann of Tulare County in an article entitled "Survey of Citricola Scale in Central California" reaches the following conclusions after careful investigations during the past eight years,

covering approximately 9,000 acres of sprayed groves and 14,500 acres of fumigated groves:

1st. "Both spraying and fumigation are necessary methods to be employed by the citrus grower in combating citricola scale in Tulare County at this time.

2nd. "When costs and efficiency are considered, conscientious fumigation with hydrocyanic acid gas has proven itself to be the proper method for the control of citricola scale on groves moderately to severely infested.

3rd. "Spraying with lime sulphur oil and spreader has proven itself to be an efficient means of preventing scale increase on groves lightly to moderately infested, providing the work is done in a thorough and conscientious manner.

4th. "Spraving with lime sulphur solution oil and spreader is the "ounce of prevention" and fumigation with hydrocyanic acid gas the "pound of cure.

Horticultural Commissioner A. E. Bottel of Riverside County in his annual report for the season of 1922-1923 states as follows:

"Results of fumigation were unusually satisfactory with the exception of two groves which were fumigated with cover crops. The average percentage kill ran 99.8%, lowest efficiency on two groves, 20 acres, 98.2%; highest efficiency on several hundred acres, 100%.

The report also shows that on the groves which were sprayed and checked, the kill ranged from 11 to 37% or an average of 25%.

Mr. Frederick Maskew, entomologist, U. S. Department of Agriculture, speaking before the 47th Calif. Fruit Growers' Convention asserted:

"With this wealth of experience on both sides of the question from which to draw; with a full knowledge of the fact that in the three great undertakings (experiments on a large scale to control insects by spraying) recited, spraving was abandoned for fumigation, with a clear comprehension of the many factors that make for success or failure in the employment of either method, and from the general average of results obtained, I state to you without hesitation that were I the possessor of a citrus orchard and it became necessary to disinfect the same for scale insects, I should employ fumigation for that purpose, and also officially advise all those who consulted me upon this matter to do likewise.

"Spraying is the contact method, and unless the contact is made results do not ensue. A tree is sprayed when it is wet all over both sides of all the leaves, twigs and branches. With an evergreen tree this is practically impossible unless at a prohibitive price, due to waste of both material and time. With the most perfect equipment success in spraying is largely a matter of the personal equation. With a perfect equipment the personal equation is almost entirely eliminated by mechanical action in modern fumigation, and last but not least, in my mind, is the fact that the instant a tent is removed from a tree any future deleterious effect to plant life is eliminated by the immediate dissipation of the gas. On the contrary, undue accumlations of spray material sometimes occur and remain after the operation, resulting in more or less injury to plant tissues."

Aside from the much greater efficiency of fumigation, it is also a well known fact that the fumigation operation in the end is cheaper than spraying, because only one fumigation operation in one season is necessary, while three or more spraying operations are required, and even repeated spraying does not give the excellent killing effect of one fumigation.

Suggestions for Simple Emergency Relief

Poisoning due to inhalation of hydrocyanic acid gas is first evidenced by dizziness; continued inhalation causes fainting; and when an overdose has been taken into the system unconsciousness and cessation of the heart action results.

In the event of fainting or unconsciousness first summon a doctor, prompt action being of great importance, and until his arrival apply the following first aid remedies.





For dizziness-Inhale the fumes from an ammonia bottle which will neutralize the HCN gas. Move patient into the fresh air.

For fainting-Have patient inhale the ammonia fumes from an ammonia bottle and induce respiration by movement of arms and walking, if possible. Walk patient against the wind, if any breeze is stirring, and keep him walking until consciousness is fully recovered.

For unconsciousness-Remove the victim from the poisonous atmosphere into the fresh air, loosen clothing, bathe face in cool water. If he is not breathing and his jaws are locked so as to interfere with artificial respiration, pry them open and wedge with a piece of wood, and remove any foreign body from his mouth.

Cyanide Accidents

Correct Method of Resuscitution

External

Begin artificial respiration at once, using the Shaefer (prone pressure) method of artificial respiration.

Lay the patient on his belly with his face to one side so that his nose and mouth are free for breathing. Place the patient's arms and hands exactly as shown in figs. 1 and 2, one arm straight out beyond his head, the other under his head.

Kneel, straddling the patient's thighs and facing his head; rest the palms of your hands on his loins with your thumbs nearly touching each other and with fingers spread over lowest ribs (see Fig. 1).

With arms held straight, swing forward slowly so that the weight of your body is gradually, not violently, brought to bear upon the patient (see Fig. 2).

Then leaving your hands in place, swing backward slowly so as to remove the pressure, thus returning to position shown in Fig. 1.

Repeat deliberately 16 to 20 times per minute, swinging forward and backward. Continue this process without interruption until natural breathing is restored and until the doctor arrives.

Keep the patient warm by whatever means are available.

Do not give any liquid by mouth until the patient is fully conscious.

Internal

Internal remedies are not recommended except by advice of a physician. In the event of an emergency and the absence of a doctor the following antidote for internal use may be taken with safety.

Cyanide Antidote-to be administered to victim taking cyanide internally.

Preparation.

- (a) 20 grains of potassium carbonate dissolved in one fluid ounce of water.
- (b) 10 grains ferrous sulphate.
- (c) 30 grains magnesium oxide dissolved in one fluid oz. of water.

Pour contents of bottle (a) containing potassium carbonate solution into a tumbler, then add ferrous sulphate (b), and finally the magnesia (c) and stirr well with a spoon.

Caution-Do not give patient ingredients separately-mix well before administering.

Administration. Have patient swallow mixture at once and lie down for a few minutes. After antidote has been given incite vomiting by tickling back of patient's throat with feather or finger or give tablespoonful of mustard in tumblerful of water.

Hydrogen Peroxide. If patient has taken cyanide internally and is conscious give immediately a teaspoonful of 3% hydrogen peroxide solution.

A small bottle of ammonia salts, hydrogen peroxide and a plentiful supply of potable water should be included in the kit of every fumigating crew wherever liquid hydrocyanic acid is being handled.

R & H Service Daily Delivery to Every District

The R & H organization maintains a fleet of motor trucks for the sole purpose of making quick delivery of Hydro-Cy and fumigating supplies direct to orchards thruout Southern California. Our trucks are built with special bodies to provide safe delivery of Hydro-Cy and we take great pride in the standard of service rendered. We realize the importance of the fumigator receiving his shipment of Hydro-Cy at the exact time desired and our determination is to maintain the highest standard of delivery.

Our product is delivered in safety drums each containing 100 pounds and each drum bears an identification number. We certify to the degree of purity of every individual shipment.

We maintain field men who are experienced in the mechanical details of our appliances and in the manufacture of our products and their duties include the frequent inspection of our apparatus throughout the different fumigation districts. We are quite as anxious as the grower and fumigator that our applicators be kept in satisfactory working condition at all times and that they operate with perfect accuracy.

charge to the user.

Hydro-Cy Pumps and Vaporizers are not sold but are either loaned or leased under our special service arrangement. This saves the fumigator the necessity of investing in costly equipment. Further information will be supplied upon request.

Whether you are a grower or fumigator we shall be pleased to send one of our sales or service men to your property and discuss with you the matter of fumigation and the different products we offer. If we can be of any service to you in furnishing any information, please feel free to call upon us. Our advisory service places you under no obligation. Correspondence solicited.

Dependable Fumigators Recommended

The majority of the groves are fumigated under the direction of professional fumigators who employ their own crews and contract to fumigate the groves at an agreed cost. It is of importance that the grower employ the most dependable fumigators and take no chances on those lacking experience. Our organization is in constant touch with dependable fumigating crews in every district in Southern California and if desired we will assist the grower in selecting his fumigating crew or in giving advice regarding this service. This company does not employ fumigating crews but is engaged in the exclusive production and distribution of cyanegg, liquid hydrocyanic acid and the necessary appliances.

Frequent Inspections

Every machine released by us receives periodical inspection without

Applicators Leased

Advisory Service

Use RH Products

Hydro-Cy

The purest liquid hydrocyanic acid guaranteed 96% to 98% pure. Delivered direct from factory to orchard by our own trucks in 100-pound safety drums.

Hydro-Cy Pump

The simplest machine for successfully *atomizing* cold liquid hydrocyanic acid. It is positively safe, gives exact dosage and is easily handled, weighing only 18 pounds.

Hydro-Cy Vaporizer

The *warm gas* machine that converts Hydro-Cy into a warm gas, more conveniently and more economically than in any other manner yet devised.

Cyanegg

Sodium cyanide, 96/98% (technical). Comes in egg form, each egg weighing approximately one ounce, for use in pot and portable generator fumigation. Sold in 100 and 200-pound cases, lots of one ton or less.



Fumigating Accessories

In addition to the above products we can furnish the fumigator with all the necessary accessories such as tapes, charts, chart holders, schedules, certified thermometers, transferring devices, etc.

Write or phone for details and prices

Pacific Rong Control HEADQUARTERS FOR HYDRO-CY FUMIGATING SUPPLIES

2575 E. 9th ST. Los Angeles

