PRELIMINARY REPORT ON THE APPLICATION OF CALCIUM CYANIDE DUST TO THE CONTROL OF HELOPELTIS IN TEA

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INTRODUCTION.

The experiments described in this report are of a strictly preliminary character, and were conducted on a very small scale. The results are presented herewith not only on account ot the great significance of the problem involved to the tea planters of South India and the necessity for the control of a pest responsible for so much damage, but also because of the promising nature of the results themselves, and because it represents the first attempt to control Helopeltis by this method.

Manufacture, Chemistry, and Reactions of Calcium Cyanide.

In order to comprehend fully the nature of the results obtained it is essential to have some conception of the material employed in the experiments, especially with regard to the characteristic properties which make its use possible in tea culture.

Briefly, it may be stated that Calcium Cyanide is prepared by a series of processes commencing with Limestone, Coke and Nitrogen derived from the atmosphere. From the two former materials Calcium Carbide is prepared; which, after being raised to a white heat, is caused to absorb the Nitrogen, liberated from liquid air by boiling. The resulting substance formed is the well-known fertiliser Calcium Cyanamide. This Calcium Cyanamide is then fused with a Sodium Chloride in an electric furnace, by which process the Cyanamide takes up one more atom of Carbon and is thus converted into Calcium Cyanide, a substance with profoundly different chemical characteristics from Cyanamide.

When Calcium Cyanide is acted upon by the water vapour present in the atmosphere, gaseous Hydrocyanic acid (Prussic acid) is produced the reaction involved in the production of this acid being explained by the following equation :—

$$Ca\,(CN)_2 + 2H_2O = Ca\,(CH)_2 + 2HCN$$

The rapidity with which this hydrolysis takes place is dependent mainly on three factors :—

1. The thinness of the layer of Cyanide
2. The size of the particle
3. The relative humidity.

The result is that a number of grades of the cyanide material are in existence, the commonest form appearing in the market being that termed commercially as " Cyanogas 'A' Dust." . This 'A' Dust is a very fine, slate-coloured powder, of which 80 per cent. will pass through a 200 mesh sieve. Using this grade, it has been determined that, when the material is spread out in a thin layer such as is formed when it is projected from an appropriate dusting machine 90 to 98 per cent. of the poisonous hydrocyanic acid gas is evolved within the first two hours, provided that the relative humidity is 35 per cent. or more. If the relative humidity is below 30 per cent. the evolution of the gas is considerably retarded. It may be added that localities with such a low humidity as 30 per cent. are more the exception than the rule in tea growing districts. The maximum concentration of the gas is attained after a period of about forty minutes, but there is very little increase after the first five minutes' exposure to the suitable moisture requirement. Further, it has been determined that the reaction takes place practically independently of the temperature. Coarser grades than the 'A' Dust are produced for certain special purposes, but where these are used, or where the thickness of any one of these grades is increased, the evolution of the gas is corrpesondingly slower.

Advantages Claimed for Calcium Cyanide.

It is claimed for Calcium Cyanide, that it has the highest range of adaptability of any other known insecticide. Arsenical or other food poisons may be effective for insects that eat solid food, while oil emulsions and other contact poisons may destroy insects of the sucking variety that sting the plant and feed upon the liquid sap of the latter. It has been shown by Andrews that the Helopeltis insect has the peculiar power of dealing with contact poisons, by systematically washing itself free from the insecticidal liquid. It was therefore concluded that spraying was of little avail against the pest; however, owing to the patent powers of Calcium cyanide as an insecticide, without the necessity of contact with the insect, it was felt that it might prove of some avail in assisting, if not completely eradicating the pest. In support of this, it may be added that Calcium Cyanide is mainly utilized as a controlling agent for insects of the sucking type, to which type Helopeltis belongs and some examples of its application to such insects which might be cited are, the elimination of plant lice, plant bugs, thrips, psyllas, fleas, etc. It may also be employed satisfactorily against certain species of leaf beetles and other insects of the biting type. These instances given by no means exhaust the application of Calcium Cyanide as a control against pests, but a discussion of all the uses of the material is outside the scope of the present article.

A further advantage of the material is the ease with which it may be transported from place to place; but possibly the greatest advantage, and one which will appeal to the South Indian planter, is due to the fact that no water is required for the application of the dust. It is a well-known fact that one of the greatest difficulties experienced by planters in their attempt to control insect or blight attacks by means of sprays is due to the inadequacy of their water supply. In the case of Calcium Cyanide no preliminary preparation of the material is required, no water has to be carried to the place of operations, the material can be applied with comparative ease and rapidity, the effectiveness of an operator equipped with a duster is approximately five times as great as one using a sprayer and finally the equipment employed is simpler, lighter, and less expensive.

A possible argument against its use in Tea may be based on the fact that Calcium Cyanide is a deadly poison. Though it must be said, before proceeding, that further work must be done with regard to any residual poisonous effects of the material, still there is sufficient theoretical and practical evidence to indicate that there is no poisonous deposit left on the leaves after a short period of time. As has already been explained in a previous paragraph, all the poison has been evolved in the form of a gas leaving behind harmless Calcium Hydroxide (Hydrated Lime). To illustrate the fact of the complete loss of poisonous residue, the leaves of a tea bush treated the previous day have been repeatedly eaten without any harmful results. While it is not pleasant to have the material blowing directly into one's face, this unpleasantness can be largely avoided by proper manipulation; and in the many experiments which have been conducted with this material in other spheres besides tea, no cooly has ever suffered injury. Thus no fatal accident has ever been reported from any country where the material is used on a very large scale.

With reference to the poisonous effects of Calcium Cyanide on mammals, it has been stated in the *Journal of Hygiene* (Vol. XXI., No. 3, May, 1923) that "it requires a concentration of 8 parts of Hydrocyanic gas in 100,000 parts of air to kill a dog in half an hour; cats die from twelve parts and goats and monkeys from twenty-five, and it may be assumed that a man will require as much as a goat or a monkey. A man becomes unconscious only when exposed to a high concentration, and if the concentration that caused unconsciousness is not increased, a comparatively long latent period intervenes before death. A person who becomes unconscious owing to exposure to moderate concentrations of Hydrocyanic gas recovers rapidly when placed in the open air."

If, therefore, 100 pounds of the straight product were used per acre this would yield twenty-six pounds of Hydrocyanic acid gas, as assuming that the whole acre were roofed over to a height of six feet and further that all the gas were given off at once, this would give a concentration within the enclosed area of 132 parts of hydrocyanic acid gas per 100,000 parts of air, or 66 parts, if the 50 per cent. dust is used. However, not more than a third of the concentration is attained at any one time, even in tents, so that even in enclosed spaces the most that could be attained would be 22. In the open air it is clear that even this concentration of 22 could not possibly be obtained under the conditions specified of 100 pounds of material to the acre, and hence it is almost a practical impossibility to obtain anything approaching a fatal dose while operating in the open air. Practical proof of this is afforded by the fact that one of us has been using the material constantly for a year and has often been enveloped in clouds of the dust, without any disagreeable consequences being experienced. Short of having the material administered in food, there appears to be no possibility of harmful results accruing from the use of the material in the open air, but it is advisable to understand the simple precautions given on the containers thoroughly, and to follow these as closely as possible throughout the operations. It is further stated that constant dusting by one cooly may result in a slight headache, and it is therefore recommended that a cooly should do one half a day's dusting and then be relieved by another cooly.

Experiments with Helopeltis.

The estate on which the following experiments were conducted is situated about four miles from Vandiperiyar, in Travancore. The bushes were in their second year from pruning and though in quite good condition, plucking had had to be postponed for a number of weeks owing to the ravages of Helopeltis.

The first test performed was made on a clump of Helopeltis insects which had been caught by children previously. This clump consisted mainly of adult insects, but also contained a number of 'nymphs' or larvae. On to this clump a small whiff of the material was blown, and within a second most of the insects were killed. Even those insects which were in the middle of the clump, and had thus escaped contact with the dust, had also been killed. From this test it was clear that the material was extremely toxic to the insects and the way was clear for field experiments.

The tests in the field were made at between three and four in the afternoon and between eight and nine in the morning. In both instances there was a fresh to heavy breeze blowing throughout the progress of the work; and further, in both cases rain fell both previous to and during the operations. Usually conditions of rain and heavy wind are not conducive to the best results in any dusting operation, but as will be seen later these factors did not diminish the degree of effectiveness to any appreciable extent.

The exact infestation per bush could not be accurately determined, even though extreme care was taken in the examination of the bushes for insects. It would appear, however, that the infestation was at least equivalent to five insects per bush. These five insects were usually found in the proportion of three adults to two larvae. In order to increase the number of insects per bush for purposes of experiment, four more insects, which had been previously collected by children, were added to each bush.

In the first day's tests, both the 'A' dust and the 'Dusting mixture' were used, the latter dust consisting of 'A' dust, diluted with an equal quantity of Superfine Sulphur, and which is especially efficacious against Red Spider. Owing to the prevailing heavy wind it was found necessary to make use of a 'Cloth trailer,' under which the dust was projected. As no canvas was available a piece of ordinary factory cloth (cotton) 6 feet wide and 20 feet long was used. This was attached in front to a light bamboo pole. A man stood in front and manipulated the sheet so as to permit of the least loss of the dust, while behind him stood the man with the dusting machine, who pumped the dust under the sheet in such a way as to secure the best possible distribution of the dust, and it was found advisable to have a further cooly assisting in the manipulation of the sheet behind. Rather a heavy application was given as it was felt that it would be easy to reduce the amount used in later experiments, provided the initial experiments were successful.

At the outset the difficulty presented itself of finding a simple, speedy, and accurate method of checking the results. As the greater part of the dead insects fall from the leaves either on to the ground or into the middle of the bush, where they cannot be found; it was decided to base our results on the number of living insects found on a number of treated bushes as compared to the number of insects found on the same number of untreated bushes. Children employed on the estate for catching Helopeltis, and hence thoroughly experienced in finding the insects, were used in the experiments. As a matter of interest it was decided to test the ability of these children in finding the insects on the bushes. Forty-eight bushes were therefore selected, four insects were added to them, so that there were at least 192 insects over the area under consideration. To this number must be added the number already present in the bushes. The children were then sent into the 48 bushes and instructed to collect as many insects as possible. The result of the first finding was only 74 insects; they were then required to repeat the find and returned after a second and third attempt with an extra 26 and 19 insects respectively per attempt. This gave a total number of insects found as 191 or 62 per cent. of the number of insects actually added to the bushes.

In the following table, giving the details of the results secured, only the living insects found are recorded, for it will be understood that it was only possible to find a very small percentage of the numbers killed, for reasons already given. The table is as follows:—

No.	Treatment	No. of lbs per acre	No. of bushes involved	Temperature		Relative Humidity	No. of insects alive after treatment	
				Wet Bulb	Dry Bulb		Larvae	Adults
1	'A' Dust	111	53	73	73	100	1	0
2	'S' Dust	110	44	75	75	100	0	4
3	Control	Nil	48	—	—	—	119 insects alive including adults and larvae	
4	Control	Nil	43	68	68	100	28	20
5	'A' Dust	100	120	68	68	100	0	0
6	Control	Nil	30	—	—	—	13	30

Discussion of Results.

Though the methods employed in checking these results were of necessity rather crude, the evidence of large numbers of live Helopeltis individuals on the controls, as compared with the practical freedom of the treated bushes from them, indicates definitely that the material has a particularly high toxicity towards the particular insect under discussion. It would appear that 'S' Dust is rather less effective in killing the insect, but it must be borne in mind that this 'S' Dust has only half the poisonous composition of the 'A' Dust, and in the experiments carried out less of the 'S' Dust was used per acre.

Conclusions

In these preliminary tests one important point has been demonstrated in a very clear manner, viz., the extreme toxicity of Calcium Cyanide to Helopeltis. Without undue optimism we can regard this fact as distinctly promising. However, when one remembers the successive failures which have accompanied any attempts to control Helopeltis, it is advisable to hesitate before making definite recommendations based on incomplete evidence. Thus, before advocating the use of Calcium Cyanide for the control of Helopeltis on tea estates under practical conditions, other important points must be subjected to rigid scientific and practical study. The following are some of the most important:—

1. The whole economics of the situation, including a standard method for accurately expressing the degree of infestation; the determination of the actual reduction in yield of leaf following upon the different degrees of infestation; and (provided control experiments are successful) the minimum degree of infestation that will justify the adoption of such control measures.

2. The minimum dosage required per acre.

3. The minimum number of applications required and the intervals between such applications. This point is important, as it must deal with the insects hatched after the previous application of the insecticide.

4. The effect of dusting with and without a trailer; the best type of trailer to use and the most advantageous method of manipulation.

5. The dilution of the dust which will give the best results, *i.e.*, whether it would be better to use a certain quantity of undiluted material or whether better results would be obtained by the use of a smaller quantity diluted to some appropriate extent with some convenient 'filler.'

6. The effect of other food plants and habitats of Helopeltis on an infestation.

7. The burning effect of the free hydrated lime remaining after the liberation of the hydrocyanic gas. This effect was noted during the experiments already described, and found to be nil; but this observation can hardly be claimed as conclusive owing to the fact that as periods of heavy rain were experienced after the application, it is more than possible that the hydrated lime was slaked at too rapid a rate to have any caustic effect, and it is further possible that a large percentage of the lime was washed away by the heavy rains.

It will be clear from the foregoing points that much work has still to be done with reference to the use of Calcium Cyanide as a controlling factor for Helopeltis; but it is hoped that all the points already mentioned, together with many others, will be made the subject matter of careful study at the earliest possible opportunity.—*Planters' Chronicle, Vol. XXI., No. 32.*