

I notice that the loans taken by the ryots under the Land improvement and Agriculturists Loans Act have been diminishing during the last 5 faslis, being Rs. 27,000 against Rs. 42,000 five years ago. It is not known whether such loans are taken by the Indian cultivators or the European cultivators. I advise you to take advantage of the facilities afforded and at the same time emphasise the need for speedy and sympathetic compliance, with loan applications, on the part of the Revenue authorities.

I am glad to hear of the Rural Re-construction Centres, established at Edapalle and Dhavani where poultry-rearing, bee-culture and agricultural improvements in general are being demonstrated. I am equally glad to be informed that arrangements are in progress to purchase and distribute the special manure mixture on a co-operative basis.

It is a happy augury that the Minister for Development, who is in charge of both the agricultural and co-operative portfolios, should open this conference, to-day because the Hon'ble Mr. P. T. Rajan is himself an agriculturist of some standing and is sure to give a sympathetic consideration to the legitimate demands and requirements of the Nilgiris cultivators.

"INSECTICIDES AND THEIR USE IN INDIA."

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Introduction. From those very early days when prehistoric man gave up his nomadic and predatory habits and began to raise crops and tend cattle the struggle between nature and man must have commenced in right earnest, man upsetting the normal conditions prevailing in the universe, and nature asserting herself every time to re-establish her supremacy. Gradually, through centuries of civilization, as this protracted struggle continued, one of the most important changes effected has been a pronounced re-adjustment of the relations that originally existed between man and the lower forms of life. Under the numerous artificial conditions brought about by human agency, what is known as the "balance of life" in nature is constantly upset especially among the lower animals like insects and one of the various resulting phenomena which frequently happens is an abnormal increase in the number of some lower forms of life which affect men—in other words, there is an outbreak of pests. Man has, of course, recognised this self-inflicted but inevitable evil through past decades and in all countries he has been compelled to devise various methods of minimising the toll levied by pests of different

* Paper read before the Agricultural Section of the Indian Science Congress at Bombay, January 1934.

kinds especially insects. In the beginning, practically all such measures were of an empirical nature without a correct knowledge of the aetiology or nature of the malady; these included among others, faith cures and indiscriminate use of sundry drugs, decoctions and miscellaneous recipes of various kinds as has been pointed out to a certain extent in a paper * read before this congress in 1921. It is needless to add, however, that while, perhaps, a few of these rule-of-thumb operations possessed the nucleus of some of our modern effective measures, the bulk of them have been found to be quite ineffective. Though the idea of controlling insect and other pests by application of medicines, etc., has been in existence from the very early days, it was not, however, until the discovery of Paris green as an effective remedy for the Colorado beetle in the United States and of Bordeaux mixture for vine mildew in France, during the latter half of the last century that the use of reliable drugs and chemicals came into use on scientific and rational lines. Since then, numerous insecticides and proprietary preparations have been discovered and at the present day, the use of insecticides has practically become a routine operation in pest infested fields in most of the regions of the world where scientific methods of agriculture are in vogue.

In this paper, it is the writer's idea to briefly indicate some of the fundamental facts regarding insecticides with the peculiar conditions prevailing in India in relation to this subject, briefly summarise the experience gained so far with insecticides and finally indicate the lines which would help in encouraging and increasing future possibilities of insecticidal methods in India.

Insecticides and Indian Conditions. Some fundamental facts regarding modern insecticides and a few remarks on the general agricultural conditions peculiar to India in this connection might help us to indicate the future potentialities of insecticidal measures in this country. Though the word insecticide literally connotes any substance that kills insects, it has nowadays gained a wider meaning and has generally come to be applied not only to different drugs and chemical preparations that are actual insect killers but also to those substances which have a deterrent effect on pests and it is in this latter comprehensive sense that the term is used in this paper. According to the nature of their action insecticides are conveniently grouped into two kinds. Against biting insects which take solid food the insecticides generally used are known as "stomach poisons"; these when eaten with the plant tissue kill the insect by absorption through the alimentary canal. In the case of sucking insects which take only liquid food, a stomach poison spread to the plant surface will not be able to reach the stomach since they get their food in the shape of sap from within the plant tissue; hence the insecticides used for such insects are

* Some local practices prevalent in S. India in the Control of Insect Pests
Agricultural Journal of India XVI, pp. 40—51. 1921.

such which will kill them by coming into actual contact with the body surface; these are called "contact insecticides." Besides these two main groups of insecticides there are others called "Fumigants" which kill insects by affecting the respiratory system in the form of a volatile poisonous gas. There is, in addition a fourth group of substances used against insects called "deterrents" which make the plant distasteful to the insect or which by their peculiar properties repel the creature from the plant. The above grouping, though convenient, is more or less an arbitrary one; for in some cases the same insecticide may function both as a stomach and contact poison or as a contact poison and a fumigant. Most of the stomach insecticides now in use everywhere are arsenic compounds which are poisonous and the important and effective fumigants are substances which evolve gases highly poisonous or inflammable or both, such as 'Potassium cyanide' and 'Carbon bisulphide'. Such substances which are poisonous have therefore to be handled and used only by properly trained persons to prevent the risk of endangering the lives of men and domestic animals. In a country like India where the majority of the cultivators are illiterate, such remedies in their hands are likely to cause more harm than good. The recommendation of such dangerous and risky substances, however effective in their own way as pest controls, is a matter which demands very serious and weighty considerations. Leaving aside this aspect of the question for the present we have first to examine and find out whether it will be advantageous to the average farmer of the Indian plains to adopt insecticidal measures of pest control against all his pests. Every one who has any correct ideas regarding agricultural conditions prevailing in India, especially regarding the comparatively small size of the Indian holdings, their proverbial poverty and the equally poor returns got out of such staple food crops like paddy and millets, can at once find out that insecticidal measures against pests on such field crops are quite impracticable and uneconomic. On the other hand, experience has shown that the use of insecticides to fight pests infesting valuable and well paying crops of different kinds is quite a practical and economic proposition. The rapid spread in these days of fruit growing, horticulture, kitchen gardening with trials of other remunerative crops is beginning to offer a very wide and encouraging scope for the adoption of insecticidal methods. The frequent transport and importation of seeds, bulbs, cuttings, fruits, etc., which take place at present especially in our ports of entry and embarkation also demand the use of insecticides for quarantine purposes. As such, the future prospects for insecticides in India do not appear so gloomy as it might have shown two or three decades ago and therefore it is a subject which demands some special attention at present.

Early trials with Standard Insecticides. Apart from the various references in early works to all sorts of local insect-killing

preparations and drugs and latterly in Watt's Dictionary of Economic products, the regular use of well tried insecticides might be said to have been started for the first time by Government gardens and owners of coffee and tea estates in the hills during the eighties of the last century. We find that London Purple was used in the Botanical Gardens, Saharanpur, for the citrus caterpillar in 1889, and the trials with Kerosene emulsion and sulphur preparations for the coffee green bug and the tea mite were started in the hill plantations of S. India, Assam and Ceylon. References to such attempts with insecticides like Chiswick compound, Gondal fluid, McDougall's insecticide, etc., and crudely-made spraying machines form interesting reading in the pages of the Indian Museum Notes (from 1891—1903) the earliest Indian periodical to record reliable facts on Economic Entomology, and in the valuable manual* on Tea by Watt and Mann. With the creation and organisation of separate departments of Agriculture in the various Indian provinces and the establishment of the Agricultural Research Institute at Pusa in the early years of this century, the different aspects of scientific agriculture including the subject of insecticidal measures to check pests received a favourable stimulus and considerable encouragement for rapid progress. The regular trials with insecticides on various crops on an organised scale and investigations in the direction of discovering suitable preparations for the different kinds of pests, were formally started on the initiative of the famous economic entomologist who sacrificed his valuable life on an insecticidal investigation in 1925—the late Professor Maxwell Lefroy who was the first Imperial Entomologist under the Government of India and under whom the writer had the unique privilege of serving his probation and picking up his first lessons in Economic Entomology nearly thirty years ago! It was Mr. Lefroy who introduced Lead arsenate into India for the first time and invented 'Crude oil emulsion' so well known and popular at present as a standard contact insecticide; the former substance was first tried for the gipsy moth caterpillar in the eastern states of America and the latter is an improved recipe on the common Kerosene emulsion. These two preparations are at present two of the best known and widely used insecticides in India. Some of Lefroy's trials with insecticides in Pusa are to be found in his bulletin of 1908.† Recognising very well the properties of the common stomach insecticides like Paris green, London Purple and Lead arsenate and realising the risk in recommending such substances to the Indian farmer, Professor Lefroy struggled hard to find out a material to replace such dangerous substances and after numerous experiments described in his memoir‡ and

* Watt and Mann "Pests and Blights of Tea" (1903).

† Treatment and observation of crop pests on the Pusa farm by Lefroy and Misra—Bull. No. 10—1908.

‡ Enquiry into the Insecticidal action of some mineral and other compounds on caterpillars—*Ent. Mem. Pusa IV(5)*, 1913.

trials in the laboratory and the fields hit upon *Lead chromate* as a stomach poison and as a fairly equal substitute to the arsenic compounds. Recent trials with this material, both in India and elsewhere, have not, however, shown very encouraging results. Lefroy continued his valuable experiments in India until he resigned his job and left India in December 1912.

Recent Experiences with Insecticidal Measures. Ever since the impetus given by Professor Lefroy in this direction and the publication of his valuable book* on Economic Entomology, educated farmers all over the country have been evincing considerable interest in this line of pest control work; the entomological staff at Pusa and in the provinces have also been engaged in testing various insecticides and recommending those that have been found effective in every way. Speaking of the numerous agricultural pests of India it is found that the majority of them are biting and chewing forms like grasshoppers, beetles and caterpillars of different kinds. The treatment of such of these forms which are amenable to insecticides can only be done under the present circumstances with arsenic compounds; and though this method is found satisfactory, in some of these cases it is felt that the conditions prevalent in India have not yet sufficiently improved to recommend the use of such poisons on a wider scale to our ryots. Until the standard of literacy improves or other non-poisonous substitutes are discovered it will not be quite safe to entrust such stomach poisons into the hands of our layman farmers. The trials with such insecticides, therefore, have been made so far only by Government departments or by educated farmers and hill planters. Experiments with stomach poisons in different places for a variety of pests have been more or less successful though in some cases they have been found impracticable. Jhaveri (i) tried Lead arsenate for hairy caterpillars in Gujarat and did not find the same effective. The writer had Calcium arsenate tried for the red hairy caterpillar in S. India last year and the results were far from encouraging. On the other hand, in the case of some of the cut worms and other caterpillars like the cotton leaf roller, arsenic compounds have been found very effective. Husain (ii) in the Punjab has found Paris green and Lead arsenate quite suitable against the pumpkin leaf beetle (*Aulacophora*). In S. India, the use of Calcium arsenate for the brinjal *Epilachna* has been found so effective that during the past two years there was widespread demand for this insecticide from numerous vegetable gardeners. The tobacco caterpillar and the castor semi-looper have also been frequently checked by these arsenic compounds in different parts of S. India. It has, however, been found to be often difficult and impracticable to use such arsenic compounds to control actively moving and

* H. M. Lefroy—Indian Insect Pests, 1906.

(i) Report of 3rd Ent. Meeting, Pusa, 1919, p. 148.

(ii) Ent. Memoir, Pusa.

polyphagous creatures like locusts and grasshoppers of sorts except in very valuable experimental plots and small nurseries where proper care can be taken to prevent risks. As already referred to before, one great disability in the use of poisonous drugs like arsenicals in the open fields of the plains is the risk of poisoning cattle; for, unlike as in many other countries, especially America, where the areas are fenced round, our fields are open, contiguous and freely accessible to stray cattle and other domestic animals.

Speaking of contact poisons and their use, however, it has to be admitted that, during the past few years, the use of this class of insecticides has not only become very popular but is spreading widely and rapidly. In orchards, kitchen and ornamental gardens and on industrial crops which pay well, sucking insects of various kinds have begun to be controlled by various contact preparations. Substances like Crude oil emulsion and Fish oil rosin soap came into use about fifteen years ago against the mango hopper and the writer's early experience with such insecticides may be found in his paper published on the subject in 1918.* The manufacture of Fish oil soap at the local Government soap factory at Calicut formed an additional impetus to the popularity of spraying for such common pests as plant lice, scales, mealy bugs, tingidids and mealy wings. In 1915-16 Misra (i) tried spraying with contact poison for the sugarcane leaf hopper (*Pyrilla*). Since the years 1917-18, when the use of tobacco decoction was given a good trial and suggested by the writer* for the plant lice pest on tobacco, this remedy has been adopted very extensively in the South Canara, Coimbatore and Guntur areas where the tobacco *aphis* often appears as a serious pest. The use of contact washes for scales was tried on a fairly large scale by the writer (ii) and Fish oil soap was found very effective against the persistent and very common scale pest (*Pulvinaria maxima*, G) of the nim tree in Coimbatore. In 1927-28, Husain † found tobacco decoction and soda rosin wash effective against the citrus *Psylla* in the Punjab. Two years ago the writer started the application of dry tobacco as a dust for thrips attack on chillies and onions as an alternative to spraying with Crude oil emulsion and tobacco decoction and this dry method has been found to be not only more effective but also to be more economic. Crude oil and allied contact materials are also now being used to check underground insects as soil fumigants, as cattle washes and as a deterrent against the fruit sucking moth. The above are some of the more conspicuous of the recent experiences with insecticides and in many of the Government

* "The mango hopper pest and its control in S. India" in "Tropical Agriculturist," Ceylon. (1918).

(i) Ent. Memoir. V. p. 130-1916—On *Pyrilla* by Misra.

* The Insect pests of tobacco in South India—Departmental pamphlet by T. V. R. Ayyar. (1918).

(ii) Ent. Memoir. VIII. (1925) on Nim scale by T. V. R.

† Ent. Memoir. X. p. 24. 1927.

research stations the use of insecticides has now-a-days become a regular routine and at the present day many private gardeners and orchardists have started stocking insecticides and appliances and carry on insecticidal operations as a regular agricultural practice. One such garden I have noted is an excellent and well conducted orchard in Panyam in Kurnool district.

A word or two may be added regarding fumigation with insecticides. Though this process has not as yet been started by individual farmers, a considerable amount of work has been done by the agricultural department all over India. In 1921, the Imperial Entomologist appears to have fumigated with success with cyanide a big cigar factory which was badly infested with the cigar beetle (*Lasioderma*). During the past two years over 300 consignments of various kinds of seeds, cuttings, plants, tubers, etc., have passed through this operation in the office of the writer for purposes of quarantine and issue of pest free certificates for commodities either going out of the country or being imported into it. The bulk of the work has been done with Carbon bisulphide and only on one or two occasions has cyanide fumigation been tried, this latter method being adopted to fumigate buildings to rid them of insect pests and other vermin. It is not unlikely that such fumigation may come into greater use when people begin to think of some effective remedy to get rid of bugs and other pests from public resorts and conveyances.

Present Position and the Future Outlook. It may be seen from the above that an increase in demand for insecticidal measures and consequently a proportionately greater need for insecticides are sure to arise in the future. It might be, therefore, advantageous to examine the different aspects of the subject, pointing out at the same time the essential needs and the existing difficulties in the matter and then put forward some suggestions for the future. In the first place there are certain important items which the party that attempts to adopt insecticidal measures should keep prominently in view to ensure success. These are, to start the operation at the proper time, use the proper material and apply it thoroughly. While it is certainly the look out of the gardener to get the necessary knowledge to judge of the correct time by gradual experience, he is practically powerless at present with regard to the other two factors—the proper material and thorough application; for, they depend a great deal on the quality of the insecticide and the efficiency of the appliances he is able to procure. Let us consider these aspects for a moment. The success of any such insecticidal measure depends mostly on the merits of the insecticides used. In the opinion of the writer the fundamental pre-requisites of any insecticide are (a) efficiency in killing or deterring the pests for which it is intended, (b) safety of the insect infested plant, (c) easy availability, and (d) comparative cheapness. The first two may be

together termed insecticidal efficiency. From the point of view of the farmer it is very important that any material which claims to be a good insect killer should not only justify its claim to that property but it should at the same time be absolutely harmless to the plant to which it is applied; otherwise the remedy will be worse than the malady. Speaking of efficiency, the important characters of insecticides in general and stomach poisons in particular are that they should be insoluble in water, incapable of being absorbed by the plant and stable in quality both while kept in stock or after application on any plant; the physical and chemical properties of the various oil preparations and emulsifying agents such as viscosity, volatility, wetting and spreading qualities, etc., are also important in the way. Now-a-days when the demand for insecticides is gradually on the increase there is naturally a tendency on the part of commercial concerns dealing in drugs and chemicals to put on the market different kinds of stuffs with all sorts of absurd claims as to their insecticidal and other properties. The purity of the ingredients of the various nostrums advertised go untested and at present Government have no control over such charlatanistic ways. In the opinion of the writer, it is none too early for the authorities to come to the rescue of the poor and credulous farmer who is sure to be dodged and cheated by unscrupulous vendors of quack nostrums. If the present state of affairs is allowed to continue the position with regard to this matter of insecticides will reach a very deplorable stage; all sorts of worthless substances will flood the market and agricultural journals with attractive advertisements of useless and untried wares and the agricultural public which has often a tendency to patronise anything that is loudly advertised goes in for such stuffs and get disappointed. Apart from misleading the public in various ways, such a position may, in course of time, affect the credit not only of reliable insecticides of tried merit but would even create some want of confidence in agricultural officers. This was the condition in the United States of America before the year 1910 and to avoid such consequences, the United States Government passed a Federal Insecticide Law in 1911. The outstanding features of this act were (1) All manufacturers of stomach poisons like Lead arsenate and Paris green should conform to the standard specifications laid down in the Act, (2) All insecticides shall bear a label containing a statement as to percentage of active and inert ingredients in the material, (3) Insecticides containing arsenic should show in the label the percentage of arsenic in different forms. (4) Criminal proceedings will be started against those for advertising substances with false or misleading labels, (5) All insecticides should be up to the standard under which they are sold, and (6) No insecticide shall contain any substance which may be injurious to vegetation. To work these provisions properly, inspectors are appointed who analyse and test samples of various proprietary remedies and institute the

usual proceedings against law-breakers. In this way the public have been protected to a considerable extent from being swindled in various ways by unscrupulous vendors of quack preparations. It is needless to add that such action on the part of the authorities will go a great way in popularising really effective insecticidal measures and helping the farmer substantially in his pest control work. In 1928, the U. S. Government brought together these insecticide laws with the food and drugs regulations and since then, a Department of Food, Drug and Insecticide (Fungicides included) administration has been in existence. The case of insecticides and fungicides is exactly on a par with Fertilizers for which legislation is often called for.

Coming to easy availability and comparative cheapness, they depend a good deal on the possibilities of getting insecticides locally made as a result of local talent and indigenous manufacture. At present many of the insecticides come from outside the country and are naturally dear and often beyond the reach of the poor ryot. There are, however, signs to show that attempts are being made here and there both by official and private chemists and entomologists to discover and introduce insecticides of different kinds from locally available materials and it is highly necessary that such attempts should be encouraged in every way. One very notable example of this kind is the attempt to make use of indigenous fish poisons as insecticides as recently described in a paper* by the Mysore Entomologist Mr. T. V. Subramaniam. There is no doubt that as years go by, numerous such discoveries will be made and cheap, safe and easily available insecticides will come into use. Until then it would be advisable, in the opinion of the writer, to stock fairly good quantities of some of the well known insecticides and appliances in agricultural co-operative societies in central villages and make these available to local farmers at reasonable prices; it is also desirable that a similar small stock should form part of the paraphernalia of the rural agricultural demonstrator in every tract. Unless insecticides are readily available at the shortest notice the opportunity for adopting the measure and saving the crop would be certainly lost in most cases. To avoid this delay to a great extent, methods of preparing home made remedies like Kerosene emulsion, Tobacco decoction, Bordeaux mixture and similar preparations, might be advised to the villagers not only by means of vernacular leaflets but by actual demonstration by the local agricultural officer.

The writer believes that, if at least some of the above suggestions placed before this gathering of agriculturists receive some attention in the future, it would contribute substantially towards the more effective and economical use of insecticidal methods in India.

* The insecticidal properties of indigenous Vegetable fish poisons - Journal of the Mysore Agricultural and Experimental Union - XIII, pp. 57-61, 1932.