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RESEARCH FOR THE PROTECTION OF FORESTRY RESOURCES, FROM INSECTS AND OTHER PESTS CONDUCTED BY THE CANADIAN FORESTRY SERVICE ON PESTICIDE AND ON ALTERNATE METHODS

by

P. C. NIGAM

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Chemical Control Research Institute
Canadian Forestry Service
Department of the Environment
Ottawa, Canada

Research for the Protection of Forestry Resources, from Insects and other Pests conducted by the Canadian Forestry Service on Pesticide and on Alternate Methods.

A. Introduction

Pesticide research in Canadian forests is mainly directed toward protection of forest resources from insect pests and diseases. The forest resources support 300,000 jobs directly and another 700,000 indirectly in secondary manufacturing and service industries, for a total of 11% of the Canadian labour force. Each of the 44 million cunits[1] of wood currently harvested generates more than $60 in wages and salaries.

Insects and other pests destroy about five million cunits of wood annually in Canada ie., approximately $300 million are lost annually from wage and salary dollars. This is equivalent to about 250,000 acres of mature forest or enough wood to meet the yearly needs of 15 newsprint mills of 1,000 tons daily capacity.

These figures do not reveal the disruption to forest management or to the rational economic development of these resources due to uncertainties of the pest outbreaks. Spruce budworm which currently infests more than 130 million acres of forest in eastern Canada, threatening the wood supply of the industry, employment, aesthetic value of the forest, habitat of wildlife, fish-bearing streams, human recreation activities and increasing fire hazard. In order to protect the forest resources from these disruptions, pesticides are used as forest management tools for maintaining a healthy forest and to obtain maximum economic, environmental and social benefits.

The philosophy of pesticide use in forestry is to spray minimum amounts of pesticide, for protection of foliage, by reducing the pest

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[1] one cunit = 100 cu. ft. of wood.

populations to the level at which they will not cause economic loss and disruption of natural balance of the various components of the forest ecosystem. The pesticides used operationally at present are of chemical origin and research is in progress with alternate pesticides and methods of control ie., biological, insect growth regulators, sex pheromones and genetic methods.

It is important to mention here that under the Canadian constitution (British North American Act) the forest resources come fully under provincial jurisdiction with the exception of national park land. Provincial departments are responsible for all administrative and operational functions relating to the management, protection, utilization and renewal of their forest resources, including the control of forest pests. However, since the federal government derives directly or indirectly, a revenue of approximately $1 billion from the forest resource sector, it is very important for the federal government that this resource is effectively protected from pests. Under the statutory authority provided by the Canadian Forestry Act of 1949, the Minister of the Department of Fisheries and Environment (DFE) provides for carrying out research, relating to the protection, management, and utilization of the forest resources of Canada.

The protection of forest from pests and fire utilizes at present approximately 39% of the total man year allotment and 37% of the total dollar resources of Canadian Forestry Service (C.F.S.). The C.F.S. program has been primarily research and development and provision of scientific and technical advice on protection of forest resources to forest managers and industry.

B. Organization

The description of various organizational units of the C.F.S. and details of their research on environmentally safe pesticides and on alternate

methods for the protection of forest resources from insect pests and diseases are outlined below:

1. Canadian Forestry Service (C.F.S.) Headquarters, Ottawa.

(a) Policy guidance, national coordination of forest insect and disease research and survey programs, budgetary allocation.

(b) Coordination of periodic reviews of aerial control projects of pests by pesticide and of problem situations likely to lead to aerial control of pests, by federal forestry, fisheries, wildlife, environmental protection, pesticide and human health officers, and by representatives of provincial departments and the forest industry.

2. Regional Forest Research Centres. (St. John's, Fredericton, Quebec, Sault Ste. Marie, Edmonton, Victoria).

(a) Research on regional forest insect and disease problem, conduct of annual forest insect surveys, mapping of major infestations, evaluation of hazard and the probability of imminent tree mortality.

(b) Consultation with and advisory services to provincial forestry departments and forest industry on areas in need of protection and on control procedures; experimental applications of pest control agents, often in cooperation with provinces and other agencies.

(c) Provision of phenological information requisite to timing of operational spray programs; assessment of results in terms of mortality and population trends of the target insect, degree of defoliation and condition of affected stands.

(d) Studies of the effects of spraying of pest control agents on non-target species (parasite, predators, other forms of life), fate of residues.

3. Chemical Control Research Institute (C.C.R.I.), Ottawa.

(a) Laboratory toxicological studies of candidate chemical and biological insecticides against selected forest insects and diseases, pilot-scale field trials of those showing promise for operational use.

(b) Laboratory and field studies of combination sprays, consisting of mixtures of chemical and biological insecticides.

(c) Development of calibration methods for determining emission rates from aircraft spraying systems, and of deposits assessment methods.

(d) Studies of insecticide residues in soil, water and plant tissues.

(e) Investigations on environmental impact of pesticide use in forest spraying operations.

(f) Advisory services to regional forest research centres, provincial departments and industry, covering the selection of insecticides and dosage rates for operational projects, and implementation of calibration and deposit assessment techniques.

4. Insect Pathology Research Institute (I.P.R.I.), Sault Ste. Marie.

(a) Laboratory research on micro-organisms and their pathogenicity for selected forest insects, and on the morphogenetic effects of juvenile hormones.

(b) Pilot-scale field trials of promising biological insecticides (Viruses, bacteria, fungi, juvenile hormones) against pest insect populations.

(c) Collaboration with regional forest research centres, provincial departments and others regarding large-scale semi-operational trials of biological insecticides.

It should be mentioned here that with the exception of Dutch elm disease most of the pesticide used in forestry is directed against the control of forest insect pests. There are approximately 100 insect species which cause economic damage to the forest. The most important of all is

the spruce budworm and most of the research in developing control agents by C.F.S. is directed towards the control of this species.

C. Research on control methods against forest pests.

1. Classical biological control Methods (Introduction of parasites, predators and pathogen).

The introduction of parasitic and predaceous insects and pathogens was the first control method employed some 65 to 70 years ago and is continuin- to the present day. Many millions of imported parasites and predators, representing about 131 insect species, and several native and exotic pathogenic micro-organisms, have been released against some 36 native or accidentally introduced forest pest species to the end of 1968. Effective control has been achieved through this method against 5 or 6 pest species, all of which were accidentally introduced (non-native) species. To date no native Canadian forest pest species have been significantly influenced by the introduction of exotic biological control agents.

2. Cultural practices: A number of cultural practices are carried out for the protection of trees from diseases and insects, in forest nurseries, plantations, urban areas and woodlots ie., emergency felling operations in the face of imminent tree mortality, or salvage operation after death of infested stands; and manipulation of cutting schedules and log-handling procedures, or use of low value trap logs to reduce beetle damage; manipulations of silvicultural practices for disease control etc.

3. Chemical pesticides: When the traditional introduction of parasites, predators and pathogens (biological control), and cultural practices fail to protect forests from wide spread infestation, then application of pesticide has been and remains the most practical approach. In large scale infestation covering millions of acres, eg. spruce budworm, hemlock loopers

etc., only the strategy of aerial application of chemical pesticides is practical. This technique has been used to control spruce budworm and other defoliators since 1940.

In general terms, the method involves a search for a candidate pesticide by screening processes involving pests and non-target species. Approximately 200 chemicals have been tested since 1940. Of these only 30 chemicals were released for field evaluation by aerial application after intensive studies for environmental effects and efficacy against the pest; and of these approximately 8 pesticides have been registered for aerial application against various defoliators. At the moment, fenitrothion, Matacil® and phosphamidon are being used on millions of acres for the control of larvae of budworm and other defoliators. This wide spread use of chemicals is of great concern to public. In spite of all the rigorous research by chemical companies, various services of D.F.E, Health and Welfare, Agriculture Canada, all the consequences of interaction of pesticide molecule with the various components of the biosphere could not be studied or even foreseen; the public concern is appreciated but as this is the only practical approach available for the protection of forest resources, we have to use it objectively until a more practical alternate method becomes available.

4. Biological Pesticide: In order to reduce the application of chemical pesticide, research is concentrating on pesticides of biological origin. The following is the status of the various biological agents:

(a) Fungi: A number of fungi are the causative agents of disease in insects. There are many cases recorded in which a naturally occurring fungus epizootic has been effective in decimating an insect outbreak. Unfortunately, despite efforts going back about a century, there have

been very few successes in attempts to spread fungi artificially. Nevertheless, the potential is so great that much effort has been expended trying to determine the cause of the failure. Evidence obtained recently suggests that before long a measure of success may be achieved.

(c) Viruses: Viruses are important factors in the natural collapse of infestations of many forest defoliators. Experimental aerial application of four viruses have given sufficiently encouraging results to warrant further testing on larger scale. However, insect viruses are not readily available commercially, thus any enlargement of the scale of application from an experimental to an operational basis of more than a few hundred acres will depend on special virus propagation programs. Large collections of diseased insects are needed for preparation of infective material. The Canadian Forestry Service is the best equipped Canadian agency to undertake the collection, processing and storage of infective virus against forest insect pests: It is doubtful that virus applications will be practical over very large areas (millions of acres), owing to problems of supply and cost, but their release should be entirely feasible over smaller infestations of susceptible species, especially in areas of high environmental sensitivity.

(d) Bacteria: Commercially available Bacillus thuringiensis preparations have been tested with promissing results against several defoliating insects and will probably be the first of the biological insecticides to be used operationally over infested forest in Canada. The scale of operational use may be limited due to higher cost, formulation difficulties and limitations of aerial application technology.

5. Mixture of Biological and Chemical Insecticides: The spray formulations combining microbial insecticides with greatly reduced quantity of chemical pesticides yield better control results than either component alone. Spray formulations of this nature will reduce environmental hazard and they need further testing to determine their practical applicability for operational programs.

6. Physiologically active pesticides:

(a) Hormone Analogs: Results of experimental aerial applications of insect growth regulators against spruce budworm and the eastern hemlock looper, suggest that these materials, which can be produced commercially, may also have a useful place in forest insect control operations. The necessity for precision timing of application, to coincide with the occurrance of the last larval instar, will probably limit their use to relatively small areas, and against insect species in which members of the population develop synchronously.

(b) Pheromones: Pheromones are chemicals secreted by one sex to act as stimulants of the other sex in relation to mating. The most obvious use of pheromones is for direct trapping, usually of the males to the end that mating will be reduced to the point of population collapse. The second method is the confusion technique. It is assumed that if a sufficient quantity of the pheromone is distributed over the infested area, the male will be unable to locate the discrete point at which a female is emitting the pheromone, and therefore successful mating is reduced to pure chance encounter. These methods are currently under investigation; and there is evidence of some success in a few cases; but much more research is necessary before pheromones can be used more widely with any prospect of success.

7. Genetic Control: Involves the genetic manipulation of populations in a manner that will result in reduced fertility, and perhaps even in suppression or elimination of populations. A principle common to all genetic control techniques is the rearing and releasing of genetically altered insects in sufficient numbers to depress fertility to a level at which insect populations could not cause economic losses. The techniques used are sterile male and inherited sterility. These techniques are attractive because they are specific and non-polluting. Though the principles are well established in modern genetic theory, their practical application provides a difficult challenge. Genetic control is still in the earliest stages of development, and operational reliability and effectiveness against forest insect pests cannot be predicted.

8. Host Management Techniques: Proper host management is essential to the long term solution of the pests and forest management problem. Without thoughtful regulation of forest development no approach to pest control is likely to meet with persistent success. On the other hand it seems equally clear that no practically feasible scheme of host management will ever, by itself, give constant protection from a forest pest like spruce budworm. When considering pest management approaches they must be integrated or combined with other more direct methods. There are four main host management approaches, block cutting, selective (including partial) cutting, short rotation management and altering forest composition. These methods suffer from two main limitations in development and applications. One is a time limitation - it will take 50 to 100 years to restructure a forest. The other is a space limitation - to be valid the treatments would have to cover areas in the order of 1 to 2 million acres. This technique is still in initial stages of research.