Agriculture Canada

Food Production
and Inspection Branch

Direction générale
Production et inspection des aliments

Plant Industry Directorate

Direction de l'industrie des produits végétaux

Discussion Document **D93-01**

Registration Status of Fenitrothion Insecticide

The special review of the registration status of fenitrothion was an initiative prompted by concerns expressed by Environment Canada regarding environmental effects of fenitrothion use in forestry. Upon consultation with Agriculture Canada's advisory agencies, namely, Environment Canada, Forestry Canada and the Department of Fisheries and Oceans, it was decided to review all available information on both the hazards and risks to the environment and the value of fenitrothion use in Canadian forestry in an attempt to reach a best balanced decision regarding the future of fenitrothion use in Canada. The purpose of this Discussion Document is to provide a summary of the data reviewed and to outline regulatory considerations and options regarding the registration status of fenitrothion. This document is presented as a basis for discussion as part of the consultative regulatory management process used by Agriculture Canada and its advisory agencies in making significant or complex registration decisions on pesticides.

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Publications Coordinator
Pest Management Regulatory Agency
Health Canada
2250 Riverside Drive
A.L. 6606D1
Ottawa, Ontario
K1A 0K9

Internet: pmra_publications@hc-sc.gc.ca
www.hc-sc.gc.ca
Facsimile: (613) 736-3798
Information Service: (613) 736-3799 or
1-800-267-6315 (In Canada only)

Canada

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1.0 Introduction

In October 1990, the Plant Industry Directorate (formerly the Pesticides Directorate) of Agriculture Canada issued Announcement Document 90-03 concerning the special review of fenitrothion insecticide. The purpose of the announcement was to notify registrants, pesticide regulatory officials, and other interested and affected parties, that products containing fenitrothion were subject to a special review under the authority of Section 19 of the *Pest Control Products Regulations.*

The special review was prompted by concerns expressed by Environment Canada in 1989 in a comprehensive evaluation of the literature entitled *The Environmental Effects of Fenitrothion Use in Forestry* (Environment Canada, Conservation and Protection, Atlantic Region).[1] In summary, there were concerns raised regarding direct mortality and indirect reproductive impairment of migratory songbirds, population decreases in honey bees and wild bees, and reductions of benthic aquatic invertebrates.

Because of the seriousness of these concerns and the fact that the last comprehensive evaluation of the environmental effects of fenitrothion was conducted in 1977[2], the decision was made to reconsider the registration status of fenitrothion. Upon consultation with Agriculture Canada's advisory agencies, namely, Environment Canada, Forestry Canada and the Department of Fisheries and Oceans, it was decided to review all available information on both the hazards and risks to the environment and the value of fenitrothion use in Canadian forestry in an attempt to reach a best-balanced decision regarding the future of fenitrothion use in Canada.

Since the release of Announcement 90-03, the Plant Industry Directorate has received information directly from Sumitomo, the principal manufacturer and distributor of fenitrothion, as well as from other interested parties on the environmental hazards of fenitrothion use in Canada. The Forest Pest Management Caucus (a national body of pest management experts representing the forest industry, provincial and federal governments, academia, various interest groups, and the forestry profession) has also prepared information on the value of fenitrothion use. Both sets of information have been shared with and reviewed by Environment Canada (which includes the Canadian Wildlife Service), Forestry Canada, and the Department of Fisheries and Oceans.

The purpose of this document is to provide a summary of the data reviewed and to outline regulatory considerations and options regarding the registration status of fenitrothion. The advisory agencies have produced the environmental risk and value assessments, and the regulatory options that appear in the document. This document is presented as a basis for

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1 Available from Communications Services of Environment Canada, 15th Floor, Queen Square, 45 Alderney Drive, Dartmouth, Nova Scotia, B2Y 2N6.
Telephone (902) 426-7990.

2 *Fenitrothion: The Long-Term Effects of Its Use in Forest Ecosystems, NRCC No. 16073, National Research Council of Canada, 1977.*

discussion as part of the consultative regulatory management process used by Agriculture Canada and its advisory agencies in making significant or complex registration decisions on pesticides.

We welcome your views on the subject matter of this document. Please address your comments within 90 days of the issue date of this document, to:

Fenitrothion Special Review
Plant Industry Directorate
Agriculture Canada
2200 Walkley Road
Ottawa, Ontario
K1A 0C5

In order to expedite the process, comments should be copied to:

Fenitrothion Special Review
Chief, Pesticides Division
Commercial Chemicals Branch
Conservation and Protection
Environment Canada
Ottawa, Ontario
K1A 0H3

Chief, Regulatory Affairs
Forestry Canada
Forest Pest Management Institute
P.O. Box 490
Sault Ste. Marie, Ontario
P6A 5M7

Any inquiries regarding this Discussion Document should be directed to:

Information Service
Pest Management Regulatory Agency
Health Canada
2250 Riverside Drive
A.L. 6605E1
Ottawa, Ontario
K1A 0K9
Telephone: 1-800-267-6315

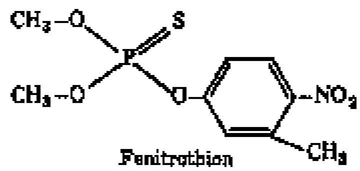
2.0 Pesticide Name and Properties

2.1 Pesticide name

Common name:	fenitrothion
Chemical name:	*O,O*-dimethyl-*O* (3-methyl-4-nitrophenyl) phosphorothioate
Trade name:	Sumithion®, Folithion®, Novathion®
CAS Registry No.:	122-14-5

2.2 Physical and Chemical Properties

Empirical formula:	$C_9H_{12}NO_5PS$
Structural formula:	



Molecular weight:	277.2
Physical form:	oily liquid
Color:	yellow-brown
Melting point:	0.3/C, pure
Boiling point:	140-145/C
Vapor pressure:	2.14×10^{-4} mm Hg at 25/C
Octanol/Water partition coefficient (K_{OW}):	3800
Solubility: water :	14 mg/L at 30/C
	dichloromethane, methanol, xylene : >1 kg/kg at 20-25/C
	hexane : 42 g/kg at 20-25/C
Specific gravity:	d_{25}^{25} = 1.32 - 1.34

3.0 Use of Fenitrothion

3.1 Development and Use History

Fenitrothion is a non-selective contact insecticide initially developed and manufactured by Sumitomo Inc., of Japan. It was also developed independently by Bayer Agriculture and later by American Cyanamid Co. Fenitrothion has been registered for use in many countries for various food crops. In Canada, fenitrothion has been used since the early 1970's mainly for spruce budworm control in forestry. Fenitrothion is a non-reversible cholinesterase inhibitor, acting on the insect's nervous system and is effective via direct contact or through ingestion of sprayed plant material.

3.2 Current Use Pattern

3.2.1 Woodlands

Eastern hemlock looper, fall cankerworm, jack pine budworm, sawflies, spruce budworm, western hemlock looper.

140-280 g a.i./ha

Ground Application: Apply as a low-volume or ultra-low-volume spray or apply as an emulsion in sufficient water for good coverage. Make a single application of 280 g a.i./ha or two applications 4 to 6 days apart of 150-210 g a.i./ha. For hemlock looper, apply before the fourth instar. For jack pine budworm, apply between the third and sixth instars. For sawflies or fall cankerworm, apply as soon as the larvae appear. For Swaine jack pine sawfly, apply at the peak of emergence of the second instar. For spruce budworm, apply as soon as insects are noted, and repeat about one week later, just before the peak of the fourth instar. When used as described for spruce budworm, spruce bud moths may also be controlled.

Limitations: Use no more than 280 g a.i./ha for any one application or a total of 420 g a.i./ha applied in two treatments.

NATURE OF RESTRICTION: This product is to be used only in the manner authorized; consult local pesticide regulatory authorities about use permits which may be required.

3.2.2 Forest

Eastern hemlock looper, fall cankerworm, jack pine budworm, sawflies, spruce budworm, western hemlock looper.

RESTRICTED 140-280 g a.i./ha

Aircraft or Ground Application: Apply as a low-volume or ultra-low volume spray or as an emulsion in sufficient water for good coverage. Make a single application of 280 g a.i./ha or two applications 4 to 6 days apart of 140-210 g a.i./ha. For hemlock looper apply before the fourth instar. For jack pine budworm, apply between the third and sixth instars. For sawflies or fall cankerworm, apply as soon as the larvae appear. For Swaine jack pine sawfly, apply at the peak of emergence of the second instar. For spruce budworm, apply as soon as insects are noted, and repeat about one week later, just before the peak of the fourth instar. When used as described for spruce budworm, spruce budmoth may also be controlled.

Limitations: Use no more than 280 g a.i./ha for any one application or a total of 420 g a.i./ha applied in two treatments.

NATURE OF RESTRICTION: This product is to be used only in the manner authorized; consult local pesticide regulatory authorities about use permits which may be required.

Do not mix with products other than those specified on the registered label.

4.0 Fenitrothion Risk Assessment

The advisory groups have prepared a complete Risk Assessment study of the environmental data. For the purposes of this Discussion Document, a summary of the Risk Assessment follows. The complete Risk Assessment has been published by Environment Canada and is available from:

Chief, Pesticides Division
Commercial Chemicals Branch
Conservation and Protection
Environment Canada
Ottawa, Ontario
K1A 0H3

4.1 Environmental chemistry and fate

a) Physicochemical properties

The vapour pressure of fenitrothion is reported to be 2.14×10^{-4} mm Hg at 25/C, which indicates that fenitrothion has an intermediate to high volatility under field conditions. Fenitrothion has the potential to volatilize from soil, particularly moist soil. Volatilization from the surface microlayer is the major means of dissipation for fenitrothion sprayed on natural waters. Water solubility values reported for fenitrothion are 5 mg/L at 10/C, 14 mg/L at 30/C, and 31 mg/L at 50/C, which indicate that fenitrothion is soluble in water. The octanol/water partition coefficient (log K_{ow}) for fenitrothion is reported to be 3.43 at 20/C, which indicates that fenitrothion has a potential for bioaccumulation in the environment. No raw data or experimental methodologies were included by the proponent to support these reported physicochemical values.

b) Transformation

The half-lives of fenitrothion via hydrolysis are 191–200 d at pH 5, 180–186 d at pH 7, and 100–101 d at pH 9. These results indicate that fenitrothion is hydrolysed under basic conditions and is more resistant to hydrolysis under neutral and acidic conditions. The major transformation product observed at pH 9 was

3-methyl-4-nitrophenol. The hydrolysis of fenitrothion and the formation of 3-methyl-4-nitrophenol are likely to proceed very slowly under the environmental conditions found in most eastern Canadian watercourses.

Phototransformation of fenitrothion on soil surfaces and in air is considered slow. Phototransformation studies conducted in water at 25/C indicated that fenitrothion had half-lives of 3.7 and 141 d under light and dark conditions, respectively, indicating that the compound can undergo phototransformation quite readily in water. The major transformation product observed was p-nitro-m-cresol, which disappears through photolytically mediated polymerization to form substances resembling fulvic or humic acids, which may then be bound to organic matter or remain in solution.

Aerobic soil transformation studies conducted using a number of soil types indicated that fenitrothion and its major transformation product 3-methyl-4-nitrophenol are microbially transformed and are not persistent in forest soils.

Aerobic aquatic transformation studies using sediments have shown that fenitrothion and its major transformation product 3-methyl-4-nitrophenol are not persistent under aerobic aquatic conditions and that microorganisms in natural sediments and water play an important role in the decomposition of fenitrothion. Anaerobic aquatic transformation studies have indicated that fenitrothion and its major transformation products aminofenitrothion and 3-methyl-4-nitrophenol are associated with sediments and are not persistent under anaerobic aquatic conditions.

c) Mobility

Laboratory studies have indicated that fenitrothion has the potential to be mobile in coarse-textured soils with low organic matter content. Fenitrothion will desorb from all soils and sediment. The major transformation product 3-methyl-4-nitrophenol was observed to be more mobile than the parent compound.

d) Field dissipation

Canadian field dissipation studies have shown that fenitrothion is present in low concentrations (<0.005–0.1 : g/g) in forest soil and is not persistent following operational aerial applications to control the spruce budworm *Choristoneura fumiferana*. Fenitrothion and its major transformation products do not leach appreciably in forest soils when applied according to label instructions.

Concentrations of fenitrothion in lotic (flowing) aquatic systems measured following operational spraying have ranged from 1.3 to 127 : g/L. Fenitrothion concentrations usually declined to less than 1.0 : g/L within 24–48 h and to less than 0.5 : g/L within 1–6 d. The half-life of fenitrothion in stream water is estimated to be 6–10 h.

Maximum aqueous concentrations of fenitrothion in lentic (standing water) systems after operational sprays have usually occurred within 2 h after the start of spraying and have ranged from 0.38 to 2500 : g/L. Mean surface water concentrations of fenitrothion in small ponds directly oversprayed with fenitrothion at an application rate of 210 g a.i./ha ranged from 20 to 1500 : g/L. A large fraction (up to 70%) of the fenitrothion applied to lakes and ponds is rapidly volatilized from the surface layer (half-life <0.5 h). Fenitrothion concentrations at depths of 0.3 and 1 m in acid bog ponds were 0.25–0.5 times the concentrations observed in the surface layer 15 min postspray. However, concentrations observed at the greater depths were not as transitory (half-life about 1 d) as the high residues observed in surface water. Aqueous fenitrothion residues reappeared 1 year after application to an acid bog pond, suggesting that some component of that ecosystem, possibly moss, acted as a reservoir.

Concentrations of fenitrothion in aquatic sediments after operational spraying were less than 0.5 : g/g and fell below detectable levels 2 d postspray in a small pond in a spruce-fir forest in New Brunswick. Aminofenitrothion, the major transformation product, persisted for less than 4 d.

Numerous Canadian field studies have indicated that fenitrothion can persist and possibly accumulate for periods of more than 1 year at concentrations of approximately 1 : g/g in conifer foliage.

4.2 Environmental Toxicology

a) Soil microorganisms and arthropods

Concentrations of fenitrothion found in forest soil immediately following operational applications to control spruce budworm are not expected to adversely affect soil microorganisms or microbial processes. Populations of soil and leaf litter arthropods were reduced by fenitrothion application, but none of the species was eliminated, and numbers recovered by the following year. However, the effects of repeated applications of fenitrothion on the soil invertebrate community and the effects of any changes in the invertebrate community on soil processes remain unknown.

b) Nontarget terrestrial arthropods

Arthropod biomass and numbers may be reduced by up to 35% and 50%, respectively, following operational applications of fenitrothion to control spruce budworm. Despite this large mortality, most invertebrate populations are affected only temporarily, because a proportion of the population of any arthropod species is likely to avoid contact with the insecticide owing to the existence of refugia in unsprayed foliage within the spray block and within individual trees. Swaine jack-pine sawfly *Neodiprion swainei* and balsam fir sawfly *N. abietis* populations may be suppressed by persistent fenitrothion residues in conifer needles. Long-term population densities of arboreal predaceous insects and spiders are relatively stable, but a few species (e.g., the ladybeetle *Mulsantina hudsonica*) remain scarce in sprayed areas.

The variability of many invertebrate predator populations over time makes interpretation of results difficult. Conventional fenitrothion spraying to control spruce budworm larvae may virtually eliminate late larval and pupal parasites from spray blocks by killing adult parasites before they have found a host suitable for oviposition. Thus, continued fenitrothion spraying may be weakening a section of the biocontrol complex operating upon budworm larvae and pupae.

c) Pollinators

Laboratory studies have indicated that fenitrothion is highly toxic to honeybees and other native pollinators. Numerous field studies have observed mortality in foraging bees and a decline in the foraging activity of honeybees in fenitrothion-treated plots compared with control plots. Aerial applications of fenitrothion at 210 g a.i./ha have caused a high mortality of native pollinators, including bumblebees, solitary bees, and vespid wasps. Time for recovery of pollinator populations ranged from 3 to over 10 years, depending upon the severity of the reductions. Fenitrothion spraying has also been observed to result in shifts in pollinator behavior. For example, bumblebees foraging in habitats sprayed with fenitrothion foraged on fewer plant species than bees in unsprayed locations, perhaps because of reduced competition in the treated areas.

Population reductions of honeybees and wild bees have been correlated with reduced seed and fruit set (plant fecundity) in various plants in natural and agricultural ecosystems. Crop losses of blueberries in New Brunswick between 1970 and 1977 due to fenitrothion spraying in surrounding forests were estimated at 670,000 kg. The implementation of buffer zones around blueberry fields has eliminated this problem in recent years. Forest plant species for which an association between reduced fecundity and fenitrothion spraying has been demonstrated include wild sarsaparilla *Aralia nudicaulis*, with a 30% reduction in fruit production; corn lily *Clintonia borealis*, 17–36% reduction; bunch-berry *Cornus canadensis*, 44% reduction; sheep-laurel *Kalmia angustifolia*, 52% reduction; wild lily-of-the-valley *Maianthemum canadense*, 27% reduction; and red clover *Trifolium pratense*, 78% reduction. The effects of the observed reductions in plant fecundity, specifically fruit and seed set, on the population biology of affected plants are unknown.

The impact of fenitrothion on forest pollinators and pollination is a definite concern. Fenitrothion-mediated reductions in pollinator abundance undoubtedly add some element of risk to the sexual reproduction of boreal forest herbs. However, population-level effects such as changes in age structure, changes in the ratio of male to female plants in an area, and inbreeding in plants have not been investigated to date. Impacts on plant populations are likely to be difficult to measure, because many flowering forest plants are long-lived perennials that, besides sexual reproduction, have well-developed clonal growth. In the absence of studies addressing sublethal effects on pollinators and the consequences of reduced production of seed and fruit for forest wildlife dependent on those food resources, a complete understanding of the impact of spraying with fenitrothion on the forest ecosystem due to effects on forest pollinators is not possible at this time.

d) Algae

The 96-h EC_{50} of fenitrothion for *Selenastrum capricornutum* was 1300 :g/L. Although it is difficult to extrapolate to other algae species, the limited data suggest that operational applications to control spruce budworm are not expected to be toxic to algae inhabiting small ponds.

e) Aquatic invertebrates

The 48-h static LC_{50} of fenitrothion for *Daphnia magna* was reported as 8.6 :g/L, with a no-observed-effect concentration (NOEC) of <2.0 :g/L. The 48-h flow-through LC_{50} of Sumithion 8E to *D. magna* was reported as 2.3 :g/L, with a NOEC of 1.0 :g/L. These reported laboratory acute toxicities indicate that Sumithion and its active ingredient fenitrothion are highly toxic to aquatic invertebrates. These acute toxicity values are well within the range of concentrations measured in small lentic habitats.

Field studies examining the effect of operational applications of fenitrothion on aquatic invertebrates in lotic systems have generally indicated an increase in drift of invertebrates from a number of different orders, which in some cases included dead organisms. Most peaks in drift occurred within the first 12 h after treatment, and the effects generally lasted less than 24 h. In the majority of these studies, no decreases in benthic populations of aquatic invertebrates were observed after spraying. In those cases in which short-term reductions in some groups did occur, the effects were transitory.

Operational sprays of fenitrothion should have only minor effects on the invertebrates associated with large lentic water bodies, as large lakes are protected by no-spray buffer zones that limit the amount of insecticide contacting the water. In addition, dilution in large bodies of water would serve to further reduce the hazard to resident biota.

An experimental ground application of fenitrothion at a rate of 210 g a.i./ha to small bog ponds produced residue concentrations that were within the range of those that have been measured after operational spraying. The application reduced emergence of a number of orders of invertebrates for a period of 12 weeks. Benthic biomass was reduced by about 50%, and recovery to control densities required about 1 year. The implications to wildlife inhabiting these areas are unknown at present.

Small ponds other than bog ponds are difficult to see from the air and hence difficult to protect with buffer zones; in addition, they have little forest canopy to screen out deposit, a small capacity for dilution, and low water turnover rates. The invertebrates inhabiting these ponds could therefore be potentially at risk from forest spraying with fenitrothion. Mean surface water concentrations of fenitrothion in small ponds (<0.5 ha) directly oversprayed with fenitrothion at an application rate of 210 g a.i./ha ranged from 20 to 1500 :g/L. These concentrations are 10–200 times greater than the 96-h LC_{50}s for some aquatic invertebrates (see above). It must be recognized, however, that maximum surface water concentrations are rapidly attenuated as a result of dilution, transformation, and volatilization and are not directly comparable with concentrations of fenitrothion used to develop laboratory toxicity values. Therefore, the toxicities measured by conventional procedures (i.e., 24- to 96-h LC_{50}s) may not accurately predict the effects of the short-pulse exposures to fenitrothion that organisms receive in the field. However, field monitoring has shown that concentrations of fenitrothion at depths of 0.3 and 1 m in acid bog ponds, although 0.25–0.5 times the concentrations observed in the surface layer, were not as transitory (half-life about 1 d) as the high residues observed in surface water. When water sampled from a small pond in New Brunswick that was operationally sprayed with fenitrothion in 1991 was bioassayed against *D. magna* in the laboratory, 100% mortality of test organisms resulted after 48 h at dilutions down to 12.5%.

At present, small ponds (<5 ha in size) are not always protected by buffer zones in most provinces, and the impact of the forestry use of fenitrothion on aquatic invertebrates in these habitats may be substantial. The potential exists for significant effects on vertebrate fauna that depend on energy flow through these trophic levels, but no studies that address this concern have been conducted to date.

f) Amphibians and reptiles

Laboratory studies have shown that fenitrothion can be toxic to frog eggs and tadpoles, with the toxicity depending upon the duration of exposure. Acute LC_{50}s for tadpoles of the green frog *Rana clamitans* are 9.9 mg/L after 24 h, 4.9 mg/L after 96 h, and below 4 mg/L after 160 h (with this exposure duration, there was 100% mortality at 4 mg/L). Amphibian eggs appear to be more susceptible than tadpoles to the toxic effects of fenitrothion; when developing Indian bullfrog *Rana tigrina* eggs were subjected to long-term fenitrothion exposures in the laboratory, effects on larval development were seen at fenitrothion concentrations as low as 0.01 mg/L.

Symptoms of fenitrothion exposure of subadult amphibians include developmental arrest, hemorrhagia, swimming difficulty, buoyancy problems, poor pigmentation, and curvature of the body axis. With green frog tadpoles, behavioral changes occurred at fenitrothion concentrations above 1 mg/L. Because initial fenitrothion residues in the surface layer of small forest ponds may be above this concentration following operational spray programs, there may be only a small margin of safety for developing amphibians during forest insect control programs using fenitrothion.

However, because these concentrations do not persist for very long, the greater threat to amphibians may stem from a reduction in their invertebrate food resource.

In eastern Canada, field monitoring studies have not detected mortality of adult amphibians after operational fenitrothion applications. This is not unexpected, because of the demonstrated ability of adult amphibians to tolerate acute organophosphorus (OP) insecticide exposure. Most monitoring studies have been concerned with finding dead adult amphibians and have not examined longer-term effects on amphibian populations that might occur through removal of invertebrate food resources or effects on amphibian developmental stages. Census data collected during a recent study in northern New Brunswick indicated that mink frog *Rana septentrionalis* population densities were consistently lower in areas where fenitrothion had been used most frequently in the 5 years preceding the census. These data suggest that fenitrothion may be having detrimental impacts on the long-term viability of these frog populations, although the influence on frog densities of other habitat quality parameters measured at the study sites could not be factored out.

No information was found on the effects of fenitrothion on reptiles.

g) Fish

The acute toxicity (96-h LC_{50}) of technical fenitrothion to various species of fish ranges from 1000 to 5000 µg a.i./L. Similar levels of toxicity are observed with Sumithion 20F, a flowable formulation. Of the various life stages tested, rainbow trout *Oncorhynchus mykiss* embryos were the most tolerant of fenitrothion, with a 24-h LC_{50} of >34 000 µg a.i./L. At less than acute toxic concentrations, fenitrothion can induce sublethal effects in fish, such as reduction in feeding activity (1000 µg a.i./L), swimming inhibition (480–750 µg a.i./L), and a decrease in reaction distance to prey (5.5 µg a.i./L).

The bioconcentration factor for fenitrothion is relatively low. The values reported range from 30 in common carp *Cyprinus carpio* muscle to 2300 in whole guppy *Poecilia reticulata*. Fenitrothion, however, is cleared rapidly from fish, with depuration half-lives reported to be between 3 h and 2 d. The half-life of fenitrothion in the guppy was 15 h.

Based on comparisons of fenitrothion concentrations detected in lotic water with concentrations required for acute toxic effects to fish, the hazard associated with direct effects of fenitrothion on fish in streams is low. The hazard due to indirect effects resulting from aerial spraying with fenitrothion on fish inhabiting lotic ecosystems is also expected to be low because of the transitory effects that have been observed on benthic invertebrates inhabiting these systems.

The overspraying of small ponds with fenitrothion can result in fenitrothion concentrations as high as 2500 μg a.i./L in surface water. Such concentrations are higher than those known to cause sublethal or lethal effects in fish food (acute NOEC of 1.0 μg/L for *D. magna*) and fish (acute NOEC of 440 μg/L for rainbow trout). Recent studies have demonstrated mortality of invertebrates and trout in bioassays conducted using water collected from a small pond oversprayed with fenitrothion during an operational application. In Canada, spray buffer zones are not necessarily required for small water bodies. For example, in New Brunswick, nondesignated rivers and lentic bodies less than approximately 3 ha in size are not buffered and thus these habitats are not protected from overspraying. The number of water small bodies in Canada is high (e.g., 10 000–16 000 ponds under 5 ha within the New Brunswick forest area). Because such ponds provide substantial areas of good quality fish habitat, particularly for brook trout *Salvelinus fontinalis*, there is cause for concern that the unprotected aquatic fauna in small ponds are at risk.

h) Birds

Birds can be exposed to chemical insecticides following aerial applications through four routes: 1) inhalation of respirable particles; 2) dermal contact with the spray cloud and contaminated vegetation; 3) ingestion of contaminated food; and 4) ingestion of residues during preening of contaminated plumage. There is little information on the relative importance of the different routes of exposure, although all four routes probably contribute to total exposure. Compared with similar OP insecticides, fenitrothion appears to be relatively toxic through the dermal route of exposure.

The sensitivity of birds to OP insecticides such as fenitrothion is highly variable. Factors thought to be important in a bird’s response to OP insecticide exposure include age, sex, body condition, nutritional status, and ambient temperature at the time of spraying. Variables such as habitat structure can influence exposure to the spray. Small birds are clearly more sensitive to fenitrothion than large birds, placing songbirds at highest risk from the spray.

The available data show that, following exposure to fenitrothion at current application rates, impacts on songbirds may include alterations in behavior, decreased reproductive success, and direct mortality. Effects on the behavior of free-living birds at these application rates can include reduced singing activity, changes in foraging strategies, and an inability to fly and elude capture.

In one laboratory study that examined bird behavior following fenitrothion administration, Zebra Finches *Poephila guttata* given fenitrothion at a dose of 1.04 mg/kg body weight had significantly diminished behavioral activity levels for 2 d following the treatment.

In the laboratory, the threshold for sublethal effects on reproduction following chronic (18–19 weeks) exposures of fenitrothion in the diet of Northern Bobwhites *Colinus virginianus* and Mallards *Anas platyrhynchos* was between 10 and 30 mg/kg feed. Residues in this range have been detected in food items of birds following operational applications of fenitrothion, but little information is available on the persistence of these residues.

In three field studies in which the reproductive success of naturally nesting songbirds was monitored, data collected following aerial fenitrothion applications at rates ranging from 280 to 1000 g a.i./ha indicated that fledging success was reduced in the treated areas. For instance, a single application of 280 g a.i./ha resulted in a lower proportion of young fledged on the treated plot during the year of treatment and a reduced recruitment of individuals in the year following the treatment. Some birds were found to be in breeding condition late in the season, suggesting that the spray had disrupted earlier nesting attempts.

When fenitrothion was applied at 420 g a.i./ha followed by 210 g a.i./ha 8 d later, most White-throated Sparrow *Zonotrichia albicollis* breeding attempts were disrupted, and reproductive success in the sprayed area was only one-third of that in a nearby control area. Behavioral responses of the adult birds included territory abandonment, inability to defend a territory, disruption of normal incubation activities, and clutch desertion. A further effect was seen on the adult population in the study area, which was reduced by one-third as a result of mortality and territory abandonment after the first spray. In this study, brain cholinesterase (ChE) activities following sprays at the above-normal application rate were inhibited to levels that can sometimes be seen following conventional (210 g a.i./ha) fenitrothion applications. This suggests that reduced reproductive success can occur following sprays at the 210 g a.i./ha application rate.

A single fenitrothion application of 500 or 1000 g a.i./ha for locust *Schistocerca gregaria* control in Senegal affected nesting success of Singing Bush Larks *Mirafra javanica* and Buffalo Weavers *Bubalornis albirostris*. Explanations advanced for the decreased reproductive success were that the insecticide terminated the process of reproduction or caused adults to abandon the nests before the young were fully fledged. Fledgling larks were also found to have severely reduced ChE levels.

In a study in which songbirds were provided with artificial nest boxes, a single application of 300 g a.i./ha had no apparent influence on reproductive success except for a nonsignificant trend towards slower growth resulting in lower final weights of the nestlings.

Decreased reproductive success is likely the result of a reduction in available food resources, direct toxicity to the nestlings, and direct toxicity to the adults, affecting their ability to forage and care for their young.

Mortality of songbirds has been observed at application rates as low as 140 g a.i./ha. Because the toxicity curves for fenitrothion are steep, small increases in the effective application rate (as a result of overswathing, navigational errors, or the vagaries of spray drift) may result in sharply increased mortality. ChE measurements support the conclusion that some songbird mortality is expected following operational fenitrothion sprays. Estimates of the extent of the mortality following standard operational sprays are difficult to make, because the relationship between levels of ChE depression and mortality is only approximate. Similarly, mortality estimates cannot be made from carcass searches, as songbird carcasses are very difficult to find and quickly disappear through activities such as scavenging and decomposition. The ChE data indicate, however, that songbird mortality occurs at a greater rate than would be apparent if only carcass searches were relied on to monitor spray effects.

Long-term effects of the spray on songbird populations are difficult to determine. Available census data for maritime songbirds do not allow an evaluation of population trends in the areas where fenitrothion has been used most heavily, and other potential influences on songbird population sizes are difficult to factor out.

The available data indicate that effects on songbirds ranging from behavioral alterations and reduced reproductive success to mortality may occur following operational fenitrothion applications. To obtain a measure of the extent and frequency of potential effects on songbirds, brain ChE activities have been monitored. The ChE monitoring data indicate that exposure of songbirds to the spray can be highly variable and unpredictable. However, the data also indicate that a large proportion of the songbird population may receive a significant exposure to the spray.

For instance, on average, almost half of the White-throated Sparrows collected following fenitrothion applications ranging from 140 to 280 g a.i./ha had a brain ChE activity level that was less than 80% of the value seen in control birds, confirming that they had received a significant exposure to the insecticide. Almost 17% of the birds collected had a brain ChE activity level below 50% of normal, which indicates that they had been exposed to a potentially life-threatening dose. These figures likely under-estimate the true magnitude of the exposure of the songbird population, as it is the less affected birds that tend to be collected during postspray collection programs. Further, White-throated Sparrows are likely to be less affected by exposure to fenitrothion than smaller birds such as warblers, which, because of their small size, may be more sensitive to the toxic effects of the insecticide.

The ChE data show that White-throated Sparrows (and other forest songbirds) may be at risk from the current fenitrothion spray program because 1) ChE measurements indicate a proportion of the White-throated Sparrow population receives a heavy exposure to the pesticide during operational applications, which inhibits their ChE activity by more than 50%; 2) some of the birds with this level of ChE activity will likely die from the exposure; and 3) a larger proportion of less exposed birds may suffer from effects associated with sublethal levels of ChE inhibition, including abnormal behavior, difficulties with flying, anorexia, increased vulnerability to predation, and compromised physiological ability to deal with natural stressors.

Other birds may also be at risk from fenitrothion applications. Waterfowl raising broods in the treated areas may suffer from the removal of their invertebrate food resource. This risk would be greatest where birds are raising broods in small ponds, as these are not buffered by setbacks during the operational spray program. American Black Ducks *Anas rubripes* and Ring-necked Ducks *Aythya collaris* are two species that might be vulnerable to insecticide-induced food removal during their brood-rearing period, as they nest in these types of habitats. Although American Black Duck broods are able to move among wetlands to avoid localized invertebrate population depressions, which might mitigate fenitrothion impacts, large-scale spray operations such as those practised in New Brunswick might result in reduced invertebrate biomass in all potential brood-rearing habitat within a brood’s home range.

In summary, the available data support the following general observations concerning forest birds. ChE data collected following operational applications indicate that songbird impacts will occur following fenitrothion treatments. A proportion of the bird population will receive a significant exposure to the insecticide; some of the exposed birds may die, and others will suffer from sublethal effects. These conclusions are supported by sporadic findings of dead or incapacitated songbirds following operational sprays. Current understanding of the biological relationships between ChE inhibition and sublethal impacts does not allow prediction of the outcome of sublethal ChE depression, but present application rates appear to be able to adversely affect reproductive success. An estimate of the total mortality resulting from any application cannot be made, and possible influences of the insecticide on the long-term status of bird populations in the spray areas cannot be assessed. ChE monitoring data reveal that high exposures may occur frequently. With present application technology, there is no known means to diminish or prevent these exposures. Because of the range of effects seen following fenitrothion applications, and because the ChE data indicate that these effects may occur frequently, concerns are raised for forest songbird populations in fenitrothion treatment areas.

Nesting waterfowl may breed in small, unbuffered ponds that are sensitive to fenitrothion and that also tend to receive direct applications of the compound. The data suggest that success of breeding waterfowl may be hampered by an insecticide-induced depletion of their prey resource.

4.3 Impact Assessment

The weight of evidence accumulated with respect to the identified and potential negative impacts caused by the forestry use of fenitrothion on nontarget fauna, including terrestrial arthropods, pollinators, aquatic invertebrates, amphibians, fish, and songbirds, and their potential ecological implications, supports the conclusion that the large-scale spraying of fenitrothion for forest pest control, as currently practised operationally, is environmentally unacceptable.

5.0 Fenitrothion Value Assessment

The Forest Pest Management Caucus has prepared a report entitled *Economic Benefit Assessment of Spruce Budworm Control in Eastern Canada* which includes a value assessment of the use of fenitrothion. For the purposes of this Discussion Document, an executive summary of the value assessment follows. The complete Value Assessment report is available from:

Forest Pest Management Caucus Secretariat
c/o Canadian Pulp and Paper Association
1155 rue Metcalf
Montreal, Quebec
H3B 4T6
(514) 866-6621
(514) 866-3035 FAX

or

Forestry Canada
Forestry Pest Management Institute
Information Office
1219 Queen St.E.
P.O. Box 490
Sault Ste. Marie, Ontario
P6A 5M7
(705) 949-9461
(705) 759-5700 FAX

5.1 Background and Scope

An assessment of the economic benefits of spruce budworm control using fenitrothion relative to *Bacillus thuringiensis* (*B.t.*.) was conducted for the Forest Pest Management Caucus, in response to a request from Agriculture Canada. This document outlines the scope of the assignment, describes the methodological approach used, and summarizes the key findings. A more complete description and analysis of the economic benefits of spruce budworm control can be found in *Economic Benefit Assessment of Spruce Budworm Control in Eastern Canada*.

The report deals exclusively with the economic benefits associated with the control of spruce budworm from the perspective of one forest management unit in New Brunswick. The report, designed to address regulatory requirements for assessing the benefits of fenitrothion in controlling spruce budworm, conforms to the benefit assessment guidelines established by Agriculture Canada. It does not incorporate economic effects associated with impacts on wildlife or wildlife habitats since this was beyond the scope of the study.

The analysis was a simulation exercise of a very complex subject. Reliable and accurate information on the long-term development of forests subject to spruce budworm attack and forest development with various pest control scenarios is not complete or fully understood. To overcome these information gaps, a stand level growth model and forest timber supply model were relied upon to simulate forest development and timber availability. Therefore, comparisons of costs and benefits under alternative spruce budworm control strategies in this study are relative in nature.

It must be recognized that in any modelling exercise of this nature there may be some degree of uncertainty associated with the results. Despite this, the important consideration in this report is the relative difference between fenitrothion and *B.t.* in controlling spruce budworm. Consequently, one variable was isolated which is most critical to this marginal analysis, namely stand yield response to varying levels of defoliation. The variability associated with stand yield impact is carried through to the analysis of economic benefits. Other sources of variability are common to both fenitrothion and *B.t.*, and are not considered in this study. The source for the measure of variability around the stand yield impact is derived from personal communication with leading scientists in this area of study.

5.2 Importance of the Forest Industry - The Need for Protection

The forest resource is important to Canadians because it provides a diverse range of benefits, which include recreational (e.g., camping) and industrial uses (e.g., harvesting). In addition, the forest resource provides tremendous existence value, such as the maintenance of natural ecosystems.

With the exception of industrial uses, it is very difficult to quantify the economic value of most forest uses (outputs) since they are not distributed through markets with associated market values. Without such market values it is difficult to determine social preferences for the various forms of forest uses. The focus of this report, therefore, is on commercial timber production.

The forest industry plays an important role in the economy of most provinces, but in New Brunswick it is most critical. Approximately 43 percent of the value added generated in the province is derived from the forest industry, compared to the Canadian average of 14 percent. The average productivity of commercial forests in New Brunswick is 1.38 cubic metres per hectare per year, compared to the eastern Canadian average of 0.65 and an overall Canadian average of 0.69 cubic metres per hectare per year. About 13,000 people are employed directly in forest-related industries in the province (i.e., logging, wood industries, and paper and allied industries). In addition, one in every three jobs in the manufacturing sector is linked indirectly to the forest industry in New Brunswick.

Based on current supply and demand projections for Canadian lumber and paper products, it is estimated that New Brunswick will face shortages of commercial timber in the near future. Pressure to protect the limited timber supply more intensively is mounting in an effort to better manage supplies in the face of increasing derived demand for lumber and paper products. Current timber supply projections assume historical levels of pest protection in establishing sustainable harvest levels. Failure to implement forest pest control programs would result in significant shortfalls in planned timber supply. Consequently, sustainable harvest levels would decline below current levels, with significant socio-economic consequences in the province.

5.3 Spruce Budworm

Spruce budworm is the most destructive forest insect pest in Canada, accounting for approximately 92 percent of the total forest area defoliated by insects in 1987. At the peak of the last infestation in 1975, some 57 million hectares of forest area were adversely affected. Spruce budworm is found throughout the range of its primary hosts — balsam fir and white, red and black spruces.

Uncontrolled spruce budworm infestations will defoliate and ultimately kill forest stands, rendering them non-commercial from an industry perspective if not salvage-harvested within three to five years. Dead and decaying stands also pose a secondary threat through increased fire risk. Evidence suggests that uncontrolled budworm infestations also have a negative impact on recreation values.

5.4 Approach and Assumptions

The approach to evaluating the economic benefits of budworm control using fenitrothion or *B.t.*, relative to no control, involved the following elements:

- Selection of one forest management unit (license) to represent the general physical and economic impact of alternative budworm controls.

- Estimation of growth impact on various stand types found within the case study forest license. This involved a simulation exercise using a stand development model, which was calibrated against actual stand impacts observed in controlled and uncontrolled budworm-infested stands in New Brunswick and Cape Breton Island, respectively.

- A "representative" budworm infestation cycle was developed for this analysis, from a combination of published sources and consultation with leading spruce budworm population scientists. This infestation scenario was used in the stand level impact analysis to generate stand yield curves for incremental levels of foliage protection ranging from 20 percent to 60 percent.

- The stand yield curves for each stand type were incorporated into a forest timber supply model for this license to estimate the impact of budworm defoliation on sustainable harvest levels over an 80-year period. The timber supply model indicated the timber supply impact for each of the defoliation levels simulated at the stand level. In addition, an error analysis around the stand level growth projections was simulated to provide a range of possible outcomes at each defoliation level.

- The efficacy of fenitrothion and *B.t.* was measured in New Brunswick from 1988 to 1991 by the New Brunswick Department of Natural Resources and Energy. Using this data source, it was clear that fenitrothion provided, on average, 20 percent greater foliage protection than *B.t.* Specifically, after weighting efficacy results by sample size across all four years, fenitrothion resulted in 33.6 percent defoliation compared to 54.2 percent defoliation with *B.t.* These results are statistically different at the 99 percent confidence level.

- Given the above efficacy difference, a conservative difference of 10 percent in defoliation was simulated in the economic analysis. That is, it was assumed that fenitrothion generates 60 percent foliage protection, while *B.t.* generates 50 percent foliage protection.

- The economic analysis involved estimation of:

    - the costs of budworm protection programs using either fenitrothion or *B.t.*,

    - the benefits, in terms of value of timber saved,

    - the net present value and benefit/cost ratio, assuming a 2, 4 and 10 percent discount rates, and

    - the employment and value-added impact associated with changes in annual sustainable harvest levels, using input/output coefficients from the interprovincial model, developed by Statistics Canada.

- The value of timber saved was estimated using a residual timber value appraisal method.

5.5 Impact on Timber Supply

The impact of budworm defoliation on timber supply (i.e., sustainable harvest levels) was simulated and results are presented in the following table.

It is evident that the use of fenitrothion allows for a higher annual harvest level (5%) relative to the use of *B.t.* Timber supply impacts are presented at three levels (low, mean and high) representing the expected variability in stand yield impacts, concerning the relationship between defoliation and stand development.

Table 1: Expected annual sustainable harvest level under alternative defoliation scenarios.

Spruce Budworm Control Scenarios/ Foliage Protection Levels	Planting Level (Ha/Yr)	Sustainable Harvest Level (cubic metres/year)		
		low	medium	high
No Infestation/ No Defoliation	1400	775,000	775,000	775,000
Infestation/ No Control - 80% Defoliation	1400	435,000	462,000	492,000
With Added Planting	3100	489,000	531,000	570,000
Controlled Infestation: Fenitrothion - 40% *B.t.*	1400	638,000	690,000	747,000
- 50% Defoliation	1400	607,000	657,000	709,000

5.6 Cost of Spruce Budworm Control Programs

The annual cost of budworm control is a function of the insecticide used, the frequency of treatment required and application costs. Spray program costs were based on actual commercial field operation programs using fenitrothion and *B.t.* The present value of foliage protection costs (based on a 4 percent discount rate, and using current application technology) are $26.2 million with fenitrothion and $32.1 million with *B.t.* The most cost-effective control strategies were identified by the New Brunswick Department of Natural Resources and Energy.

5.7 Economic Benefits of Budworm Control

Two components of economic impact were evaluated for the case study forest license, including:

- the financial benefits of increased timber harvest yields associated with spruce budworm control using fenitrothion or *B.t.*, relative to no controls, and

- the impact on jobs and value-added associated with reduced sustainable harvest levels.

It is evident from the timber supply results presented in Table 1 that the use of fenitrothion generates a higher sustainable harvest level (638,000-747,000 m^3) relative to *B.t.* (607,000-709,000 m^3), assuming a 10 percent efficacy difference. This translates into a net financial benefit (net present value) of $83 to $107 million with fenitrothion, and $68 to $89 million with *B.t.*, using a 4 percent discount rate. While both fenitrothion and *B.t.* provide very positive net benefits from a commercial timber supply perspective, fenitrothion generates about 22 percent higher net present value than *B.t.*

In the absence of active budworm control programs, the option of increasing planting levels to partially offset the timber supply impact is not profitable. Specifically, the present value of additional timber supply with increased planting ranges from $16 to $23 million. However, the cost of additional planting is $33 million, resulting in a net loss of $10 to $17 million.

The ratio of benefits to costs (present value of timber saved/present value of control costs) is 4.2 to 5.1 for fenitrothion and 3.1 and 3.8 for *B.t.*

The results of this analysis do not change substantially if a discount rate of either 2 or 10 percent is used.

Table 2: Economic benefits of spruce budworm control in one forest license in New Brunswick using fenitrothion or *B.t.*, assuming a 4 percent discount rate.

Budworm Control	Present Value of Timber Saved ($ million)	Present Value of Control Costs ($ million)	Net Present Value ($ million)	Ratio of Benefits to Costs
Fenitrothion				
low	109	26	83	4.2
medium	121	26	94	4.6
high	133	26	107	5.1
B.t.				
low	100	32	68	3.1
medium	111	32	78	3.4
high	121	32	89	3.8

In addition to the financial benefits of budworm control, changes in the annual harvest level will also impact on employment and value-added (gross domestic product) within the province. The input/output model indicates that for each 1000 cubic metres of timber harvested, 2.8 new jobs will be generated somewhere in New Brunswick and an additional 1.9 jobs will be created in other provinces. Additionally, for each cubic metre of timber harvested, $83 of value-added will be created locally with $53 of value-added created in other provinces.

Applying these coefficients to the case study, up to 154 jobs and $4.5 million in value-added would be lost if fenitrothion was removed from the market and *B.t.* was used. This result is predicated on a conservative 10 percent efficacy difference between these two insecticides occurring indefinitely.

It is important to note that the above economic benefits relate to the timber supply impact within one of ten forest licenses in New Brunswick. Although it is difficult to extrapolate these benefits to the rest of the province with any degree of accuracy because of the unique forest conditions in each forest license, it is obvious that the total net benefit of fenitrothion to the province would be very substantial.

5.8 Summary

The forest industry is important to the economy of New Brunswick in terms of employment and the value-added that is created. Current projections indicate that the demand for timber is outstripping supply, and that there is little opportunity to increase timber supply by harvesting new and more remote forest regions. This means that the commercial forests must be protected.

Uncontrolled spruce budworm infestation can seriously reduce the productive capacity of commercial forests by as much as 33 percent. Budworm control can save large volumes of timber. Fenitrothion has been demonstrated to be most effective in controlling spruce budworm and results in higher net benefits relative to *B.t.*, by as much as $15 to $21 million in net present value, in only one forest license. This benefit would be much higher for the province as a whole.

6.0 Regulatory Options

At Agriculture Canada's request, the advisory agencies, Environment Canada, Forestry Canada and the Department of Fisheries and Oceans, have compiled a list of potential regulatory options regarding the use of fenitrothion in forestry. Following each option are projected consequences that could occur in the context of the Risk and Value Assessments. There may be alternative options not listed in this document. As part of the consultative process, one of the purposes of this Discussion Document is to generate comments and suggestions from other agencies and parties.

Option 1 - Immediate Cancellation

There would be no further use of the compound after the publication of the Decision Document.

Comments

- Would immediately eliminate the adverse effects on non-target organisms identified in the Risk Assessment.
- There is an alternative (*B.t.*) available which is generally less toxic to non-target organisms.
- Would eliminate forestry sector benefits associated with the use of fenitrothion as identified in the Value Assessment.
- *B.t.* as an alternative is considered to be less efficacious against spruce budworm under some circumstances.
- *B.t.* is not registered for the control of some forest pests for which fenitrothion is registered.

Option 2 - Continued Registration For 3-5 Years Followed By Cancellation, With Increased Use Restrictions To Mitigate Adverse Effects On Non-Target Organisms

Fenitrothion could only be used for three to five spray seasons following the publication of the Decision Document.

The following restrictions would be placed on fenitrothion application:

a) Applications would be restricted to areas where populations are known to be high as determined by provincial authorities, and where *B.t.* is unlikely to provide adequate efficacy.

b) A buffer zone of 500 metres would be required around all lentic water bodies including impoundments, beaver ponds, and bog ponds appearing on a 1:50,000 topographical map. This buffer zone would also be required for any lentic water bodies visible from the air. In addition, all provincial restrictions regarding the protection of aquatic habitats would apply.

c) No area would be treated with fenitrothion in consecutive years.

d) No single application would exceed 210 g a.i./ha.

Comments

- These restrictions would reduce the total area eligible for protection with fenitrothion, but adverse effects on non-target organisms would continue in areas where fenitrothion is used. However, buffer-zone requirements should reduce adverse effects in lentic systems, and the restriction on treatment of any area in consecutive years should allow time for some recovery of affected populations of non-target organisms.

- With the cancellation of the registration at the end of the 3-5 year period, all effects of fenitrothion on non-target organisms would be eliminated.

- The 3-5 year period prior to cancellation would provide the opportunity for the development of alternative pest control strategies and would ensure that, during the interim period, the product may be used to treat those areas most vulnerable to insect damage.

- At the time of cancellation, forestry sector benefits associated with the use of fenitrothion would be eliminated.

Option 3 - Continued Registration With Increased Use Restrictions To Mitigate Adverse Effects On Non-target Organisms

The registration of fenitrothion would be maintained with the following restrictions:

a) Applications would be restricted to areas where populations are known to be high as determined by provincial authorities, and where *B.t.* is unlikely to provide adequate efficacy.

b) A buffer zone of 500 metres would be required around all lentic water bodies including impoundments, beaver ponds, and bog ponds appearing on a 1:50,000 topographical map. This buffer zone would also be required for any lentic water bodies visible from the air. In addition, all provincial restrictions regarding the protection of aquatic habitats would apply.

c) No area would be treated with fenitrothion in consecutive years.

d) No single application would exceed 210 g a.i./ha.

e) These restrictions would be reviewed periodically to ensure the continued protection of the environment.

Comments

- These restrictions would reduce the total area eligible for protection with fenitrothion, but adverse effects on non-target organisms would continue in areas where fenitrothion is used. However, buffer-zone requirements should reduce adverse effects in lentic systems, and the restriction on treatment of any area in consecutive years should allow time for some recovery of affected populations of non-target organisms.

- Adverse effects on non-target organisms, that are not effectively mitigated by the use restrictions, would continue.

- These restrictions on use may encourage the development of alternative pest control strategies while ensuring that the product may be used to treat those areas most vulnerable to insect damage.

- With this option, the forestry sector would maintain some of the benefits associated with the use of fenitrothion.

Option 4 - Continued Registration With No Change In Current Use Pattern

Continued registration with no change in label restrictions.

Comments

- The Risk Assessment concluded that the large-scale spraying of fenitrothion for forest pest control, as currently practised operationally, is environmentally unacceptable.

- With this option, the unacceptable environmental effects identified in the Risk Assessment would continue.

- The benefits of fenitrothion use to the forest sector, as identified in the Value Assessment, would be maintained.

Recommendations

Forestry Canada, Environment Canada, and the Department of Fisheries and Oceans will provide their public recommendations on the use of fenitrothion in forestry following consideration of environmental, forestry sector, and other stake-holder responses to this Discussion Document.

7.0 Regulatory Management Process

Agriculture Canada and the advisory agencies use a regulatory management process in making significant or complex registration decisions on pesticides. This approach involves a consideration of both the scientific and public policy aspects of the risks and values associated with pesticide use.

The determination of the value component of the continued use of fenitrothion in forests involved the assessment of the performance of the material and the examination of the economic benefits of its use. The performance and economic merits can be scientifically measured, within certain practical limits, and assessed by experts. However, in a public policy context, the value component also merits comments from other parties, including users, by whom it will ultimately be judged.

The determination of the environmental risk component of fenitrothion use in forests involved a complex assessment of the hazards and risks of fenitrothion to pollinators, birds, aquatic invertebrates and other organisms in the ecosystem. Potential risks can be measured scientifically and assessed by experts. However, in a public policy context the risk component also merits comments from other parties, including environmental agencies, forest industries, other levels of government, the public and users.

It is against this background, and in keeping with recognized decision-making procedures, that Agriculture Canada is undertaking public consultation by way of this Discussion Document. Responses to this document will be taken into consideration in making the necessary regulatory decision regarding the registration status of the use of fenitrothion in forestry.