Canadian Forest Nursery Weed Management Association

Proceedings of Annual Meeting,
July 8-9, 1991, Fredericton, N.B.

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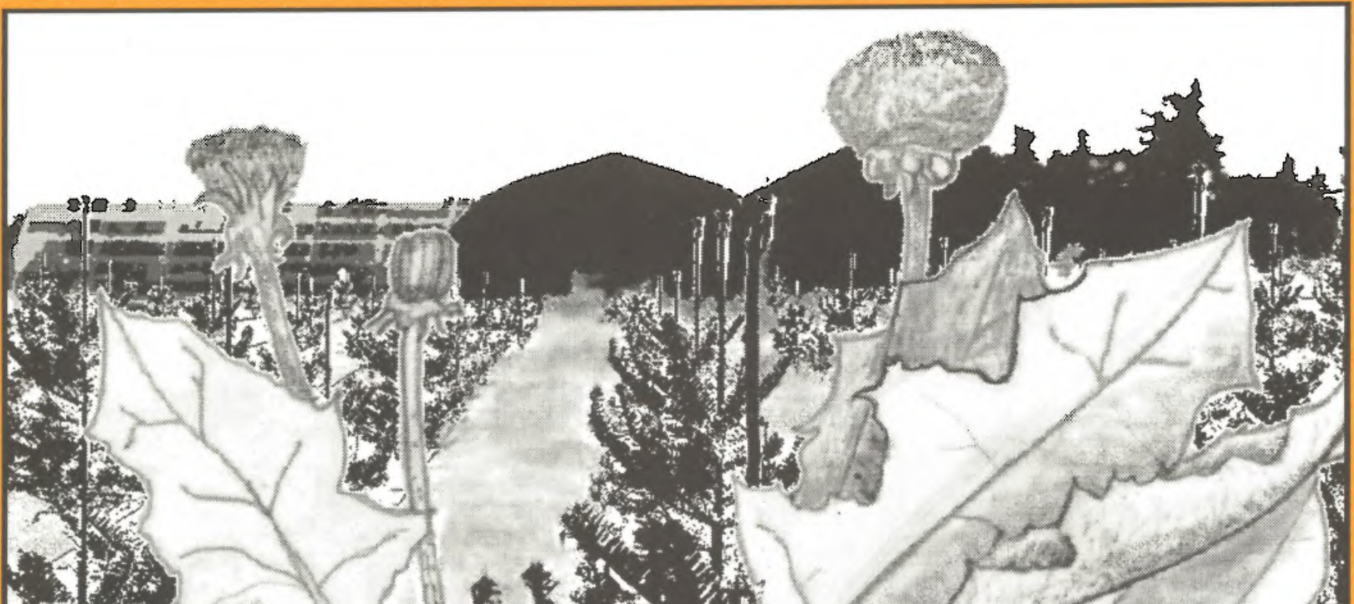

Forestry Canada Forêts Canada

Canada

Forestry Canada

Forestry Canada is the main focus for forestry matters in the federal government. It provides national leadership through the development, coordination, and implementation of federal policies and programs to enhance long-term economic, social, and environmental benefits to Canadians from the forest sector.

The Department is a decentralized organization with six regional forestry centres, two national research institutes, and seven regional sub-offices located across Canada. Headquarters is located in the National Capital Region.

In support of its mandate, Forestry Canada carries out the following activities:

- Administers forest development agreements negotiated with the provinces.
- Undertakes and supports research, development, and technology transfer in forest management and utilization.
- Compiles, analyzes, and disseminates information about national and international forest resources and related matters.
- Monitors disease and insect pests in Canada's forests.
- Provides information, analyses, and policy advice on economics, industry, markets, and trade related to the forest sector.
- Promotes employment, education, and training opportunities in the forest sector.
- Promotes public awareness of all aspects of the forest sector.

The Department interacts regularly with provincial and territorial governments, industry, labor, universities, conservationists, and the public, through such bodies as the Canadian Council of Forest Ministers, the Forest Sector Advisory Council, the Forestry Research Advisory Council of Canada, the Canadian Forest Inventory Committee, the Canadian Committee on Forest Fire Management, the Canadian Interagency Forest Fire Centre, and regional consultative committees. The Department is also active in international forestry agencies, such as the International Union of Forest Research Organizations and the Food and Agriculture Organization, as well as in technical and trade missions.

Forêts Canada

Forêts Canada est l'organisme principal en matière de foresterie à l'intérieure du gouvernement fédéral. Chef de file sur le plan national, il assure la préparation, la coordination et la mise en oeuvre des politiques et programmes fédéraux et environnementaux à long terme offerts aux Canadiens par le secteur forestier.

Le ministère est une organisation décentralisée: six centres de foresterie régionaux, deux instituts de recherche nationaux ainsi que sept sous-bureaux régionaux sont répartis dans tout le Canada. Le siège social est établi dans la région de la Capitale nationale.

Pour remplir son mandat, Forêts Canada assume les tâches suivantes:

- il administre les accords de développement forestier conclus avec les provinces
- il entreprend et appuie la recherche, la mise au point et le transfert technologique dans le domaine de la gestion et de l'utilisation des forêts
- il rassemble, analyse et diffuse de l'information sur les ressources forestières nationales et internationales et les domaines connexes
- il fait des relevés des maladies et des insectes ravageurs des forêts canadiennes
- il fournit de l'information, des analyses et des conseils (quant aux politiques) concernant l'économie, l'industrie, les marchés et le commerce reliés au secteur forestier
- il encourage les Canadiens à prendre conscience de tous les aspects du secteur forestier.

Le ministère entretient des rapports sur une base régulière avec les gouvernements provinciaux et territoriaux, l'industrie, le monde du travail, les universités, les environnementalistes et le public par l'entremise d'organismes comme le Conseil canadien des ministres des Forêts, le Conseil consultatif du secteur forestier, le Conseil consultatif de la recherche forestière du Canada, le Comité de l'inventaire des forêts du Canada, le Comité canadien de gestion des incendies de forêt, le Centre interservices des feux de forêt du Canada et des comités consultatifs régionaux. Le ministère joue également un rôle actif dans des organismes internationaux de foresterie comme l'Union internationale des organisations de recherche forestière et l'Organisation pour l'alimentation et l'agriculture, de même qu'au sein de délégations de nature technique ou commerciale.

CANADIAN FOREST NURSERY WEED MANAGEMENT ASSOCIATION
PROCEEDINGS OF ANNUAL MEETING

Fredericton, New Brunswick
July 8 - 9, 1991

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Abstract

This was the 8th annual meeting of the Canadian Forest Nursery Weed Management Association. There were 32 participants, including individuals from Newfoundland, New Brunswick, Nova Scotia, Saskatchewan, Ontario, and British Columbia. Various topics were presented and discussed such as national research network on biological control of competing vegetation, identification and life cycle of weed species, efficacy and crop tolerance of various experimental herbicidal products, spray technology, computerization of abstracts for Expert Committee on Weeds and computerized pest control system. Vegetation management is an important component in the production of tree seedlings for reforestation. The future prospects for vegetation management include development of biological control strategies and environmentally friendly and safe herbicidal products, improved cultural practices to decrease weed problems and education related to integrated vegetation management.

Résumé

Ceci était la 8$^{\text{éme}}$ assemblée annuelle de l'Association canadienne pour le contrôle de la végétation concurrente dans les pépinières forestières. Il y avait 32 participants, y inclus des individus de la Terre-Neuve, du Nouveau-Brunswick, de la Nouvelle-Écosse, de la Saskatchewan, de l'Ontario et de la Colombie-Britannique. Divers sujets ont été présentés et discutés, tels que : le réseau national de recherche sur la contrôle biologique de la végétation concurrente, l'identification et le cycle vital des adventices, l'efficacité de divers produits herbicides expérimentaux ainsi que la tolérance des essences, la technologie des pulvérisations, l'informatis-ation des résumés du Comité d'experts de la malherbologie, et un système de lutte antiparasitaire informatisé. Le contrôle de la végétation est une partie intégrale de la production des semis pour la réforestation. Les perspectives d'avenir du contrôle de la végétation comprennent le développement des stratégies de lutte biologique, des produits herbicides sûres et écologiques, des meilleurs pratiques de culture pour diminuer les problèmes d'adventices, et une formation reliée au contrôle intégré de la végétation.

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1. BICOVER - A National Research Network on Biological Control of Competing Vegetation

Dean G. Thompson
Forestry Canada - Forest Pest Management Institute

Paper prepared by D.G. Thompson, A.K. Watson, C. Dorworth, M. Dumas, G. Strunz, R. Jobidon, P. Harris, J. Castello and R. Wagner for presentation at the International Weed Control Congress held at Melbourne, Australia in 1992.

Introduction

To date, competing vegetation in Canadian forest regeneration has been controlled primarily using manual, mechanical or chemical strategies. Continued over-reliance on these techniques conflicts with the philosophy of integrated management and with public concern for the environment, particularly as it relates to the use of synthetic herbicides in forestry. Recent surveys overwhelmingly suggest that both foresters (37%), and the public (70%) view the use of chemicals in forest management as hazardous. In addition, a majority of professional foresters (57%) indicated a preference for use of biological pesticides with all relevant factors considered (1). While these views may not have a substantial basis in science, Forestry Canada has taken a lead role in addressing the two primary needs in order to meet this challenge. The first of these relates to the requirement for credible research efforts in alternative vegetation management techniques. In this regard, a more holistic and ecologically-oriented approach involving integration of all methods of vegetation management (no action, mechanical, manual, chemical, silvicultural, biological) applied on a site prescription basis is required (2). The logical second step is demonstration of scientifically defensible techniques as "best practices" for vegetation management through implementation in demonstration forests.

In practical terms, various constraints impair the potential for full delivery of an Integrated Vegetation Management (IVM) capability, including the facts that:

a) manual techniques are labor intensive, have a high risk in terms of worker safety, and are generally inappropriate for re-sprouting species (2);

b) in general, mechanical methods are economically feasible only when applied in small-scale situations where slope is minimal. The mechanical approach is generally inappropriate as a primary strategy for the scale of vegetation control required in Canadian forest renewal owing to the costs and environmental implications of burning increasing amounts of fossil fuels;

c) the use of synthetic chemical herbicides is constrained by public opposition due to fears of potential health and environmental effects, a high degree of governmental regulation and a relatively small Canadian forest market. All of these factors combine to provide a strong disincentive to industries interested in the development of new synthetic herbicides (3);

d) taking no action to control competing vegetation is inappropriate for many Canadian cutover sites where current forest harvesting practices create conditions that favor subsequent colonization and growth of pioneer or "weedy" plant species, which typically out-compete new tree seedlings for required water, light, and nutrients;

e) the potential utility of either silvicultural (except prescribed burning) or biological options for control of competing vegetation is constrained almost entirely by lack of research and development.

In addressing the paucity of research and development associated with biologicals, Forestry Canada has focused efforts to discover and develop biological and/or biorational control options through initiation of a national research network. In this context, the term "biological" is applied broadly to the use of any living organism *per se* to elicit control of undesirable vegetation, while "biorational" refers typically to secondary metabolites (hereinafter - natural phytotoxins) derived from microbial pathogens or allelopathic higher plants. As a whole, **BICOVER** (**Bi**ological **Co**ntrol of **Co**mpeting **Ve**getation **R**esearch) has as its goal, the successful development of economically viable and ecologically sound biological/biorational control agents for use against competing vegetation in Canadian forestry. This need is particularly critical to Canadian forestry because, as stated previously, small market potentials limit industrial interests in developing new synthetic products, and public concerns result in severe constraints on the limited number of products that are currently registered.

BICOVER Network Structure and Objectives

The BICOVER network enhances and accelerates research and development of biological/biorational control options for Canadian forestry by funding, coordinating, and conducting a prioritized program of research. Proposed and initiated in 1991, the structural organization of the network has been derived in the form of a "liquid-crystal" model, which incorporates fundamental networking concepts of liquidity, flexibility, linkage, interaction, and growth within a more solid overall structural framework. Such a structural organization provides for significant collaboration between sub-networks focusing on the potential use of biological organisms (herbivores, allelopathic plants; bacterial, viral, and fungal plant pathogens) and a sub-network studying natural phytotoxins that may play a role in plant pathogen (4,5) and allelopathic plant (6) interactions. The structural organization stimulates the multi-disciplinary interaction of biologists and chemists essential to developing a fundamental understanding of the specific plant-pathogen or plant-plant interactions. The fundamental knowledge developed in the discovery phase of the research program is critical to the ultimate development and use of either the live organisms or natural phytotoxins as biological and biorational control agents, respectively, in the delivery phase. The practical potential of these two strategies is demonstrated by the recent registration of BIOMAL (a fungal pathogen of *Malva* spp.) as the first biological for weed control in Canada (7) and the successful development of BIALAPHOS, a natural phytotoxin derived from *Streptomyces viridochromogenes*, as a biorational product registered in Japan for weed control in rice production.

Current Research

The ultimate objective of the BICOVER research program is delivery of biological/biorational control agents to forest managers. Priority target species include; *Rubus idaeus, Alnus rubra, Populus tremuloides, Calamagrostis canadensis, Acer rubrum, Prunus pennsylvanica,* and *Epilobium angustifolium,* which are primary competitive species throughout many of the major forest regions in Canada. In addition, specific problem species with a more regional character, *e.g., Gaultheria shallon, Kalmia angustifolia, Rubus parviflorus, Rubus spectabilis,* and a variety of other common nursery weeds, are also considered as high priorities. Current research projects being advanced under the auspices of the network include studies on indigenous fungal plant pathogens, viral plant pathogens, bacterial pathogens and natural phytotoxins directed toward control of the previously mentioned targets.

Fungal Pathogens

Research efforts by Wall and coworkers (8,9) have clearly demonstrated the potential of *Chondrostereum purpureum* for control of resprouting of *Populus tremuloides* as well as other competing brush species (*Alnus* spp., *Rubus* spp.). Current efforts are focused on further examination of the efficacy under field conditions, optimization of fermentation culture as well as initial bioassay of culture filtrates to determine the possible role of high molecular weight phytotoxins in pathogenicity of this species. *Colletotrichum dematium* is a second fungal pathogen under investigation. Patented by Dr. A.K. Watson and R.S. Winder (MacDonald College, McGill University), *C. dematium* is an indigenous pathogen of *Epilobium angustifolium*, a common pioneer and problem species in many forest cutovers across Canada. Further research and development on *C. dematium* currently involves optimization of culture conditions for conidia production in conjunction with host range and virulence studies. In addition, basic formulation research is being conducted to establish conditions required for maintaining conidia viability preparatory to small plot field screening during the next growing season.

Natural Phytotoxins

The potential of phosphinothricin, a natural phytotoxin derived from *Streptomyces viridochromogenes*, the active ingredient of bialaphos, has been shown through the effective control of both *Rubus idaeus* and *Kalmia angustifolia* in near-operational research trials (10,11). Notwithstanding problems associated with industrial patenting, the fact that this product is registered for use on a major food crop (rice) in Japan, confers an increased probability of a future registration for Canadian forestry. In advancing this product, research within the network is currently focused on experiments investigating the tolerance of primary crop species: *Picea glauca, Picea mariana, Pinus resinosa,* and *Picea abies.*

Additional research in the natural phytotoxins sub-network includes isolation and structural elucidation of secondary metabolites of *Bipolaris sorokiniana*, a fungus with documented pathogenicity on grass species including *Calamagrostis canadensis* and recently initiated studies on the possible role of phytotoxins of indigenous rhizobacteria known to inhibit germination and/or root growth. As noted previously, similar studies are continuing on the role of phytotoxins in pathogenicity of *C. purpureum*, while studies on *C. dematium* are imminent.

Bacterial Pathogens

Following screening of over 800 isolates of indigenous rhizobacteria from forest sites in Ontario, eight isolates (presently unidentified) that clearly inhibit seed germination and growth have been selected for further culturing, identification, and study. Similarly, rhizobacteria associated with decadent *C. canadensis* in the interior of British Columbia have been collected, and isolates are currently being purified, characterized, and stored in working culture (as well as semi-permanent culture to minimize attenuation of virulence). The most promising candidates will be screened subsequently, using a variety of bioassay techniques to identify the most promising candidate organisms for future work.

Viral Pathogens

The possibility of using viral plant pathogens as biological control agents of competing vegetation has been recognized by the network as a novel idea with sufficient merit for preliminary investigation. A review of the literature on plant virology associated with priority target plant species has been conducted and will be the basis for a network decision as to whether and how to proceed with further research in this area. In addition, basic work has been initiated on collection and development of pure cultures of viral pathogens of *Rubus, Calamagrostis,* and *Epilobium* host plants together with development of appropriate antisera.

Herbivores and Allelopathic Plants

Funding limitations and research prioritization have prohibited research efforts in these sub-networks in year 1 of network operation; however, flexibility in network structure provides for future research in the use of herbivores and/or allelopathic plants. The strong potential of the latter approach for control of undesirable vegetation in forestry has been previously demonstrated (12,13,14).

Summary and Prospectus

Fundamental research on a number of fungal and bacterial pathogens of priority competing species in Canadian forestry provides a basis to suggest that these areas have promise as potential biological control agents. The further research required to develop and ultimately deliver these products as components of an integrated vegetation management strategy will be a high priority in future research initiatives. Since guidelines for registration of microbial pesticides in Canada are still evolving, and identification of natural phytotoxins involved in plant pathogenicity has become a requirement for registration of microbial products (R-Memo R9003, August 1, 1990), research on natural phytotoxins will also continue as a high priority area of research within the network. In this regard, research specifically directed at development of knowledge-based regulatory protocols for these products is essential. Finally, while research on viral plant pathogens, allelopathic plants, and herbivores has not yet been undertaken to any extent, there is no *a priori* reason to reject these areas as additional avenues that may ultimately provide products with a role in biological/biorational control. Thus, the comprehensive approach to research within the BICOVER network will continue with an appropriate emphasis on short- and long-term projects which may ultimately lead to delivery of biological/biorational control agents as cost-effective, efficient, and environmentally acceptable alternatives in an overall integrated vegetation management strategy.

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2. Identification and Life Cycles of Weeds

Kevin McCully
New Brunswick Department of Agriculture

Abstract

Weed identification and knowledge of life cycles are important components of a successful weed management program. Weeds can be classified based on life cycle and reproductive strategy - annuals, biennials, and perennials. Types of vegetation include grass, sedge, rush, broadleaf, fern, and woody.

Weeds can be a major problem in agriculture as well as in forestry. A successful weed management program is based on identification of weeds, knowledge of life cycles, and comprehension of why individual weed species grow in specific locations.

Life cycle and reproductive strategy of weed species are two important factors to consider when developing a weed management program. Weeds can be classified as annuals, biennials or perennials:

ANNUALS are weeds which complete their life cycle from seed in less than 1 year. There are two categories: *summer annuals* which germinate in spring, mature, produce flowers and seeds, and die before winter; and *winter annuals* which germinate in the fall, overwinter in a seedling or rosette stage, mature, produce flowers and seeds, and die in the spring or early summer.

BIENNIALS complete their life cycle over 2 years. During the first year the seeds germinate and develop a basal cluster of leaves and tap root. The plant overwinters in this stage. During the second year, the plant produces a flower stalk, forms seeds and dies.

PERENNIALS live for more than 2 years. Perennial weeds can reproduce by seed, roots, or by vegetative means.

Weeds can also be classified as grass, sedge, rush, broadleaf, fern, and woody.

GRASSES can be annuals or perennials. These plants usually have narrow, erect, parallel veined leaves. They have jointed stems, usually hollow at the internodes and are circular in cross section.

SEDGES are perennial grass-like plants associated with wet, poorly drained soils. The stem is triangular in cross section, solid and not jointed.

RUSHES are annual or perennial plants similar in appearance to sedges with grass-like tufted leaves at the base. Stems are hollow, circular in cross section and not jointed.

BROADLEAF weeds can be annual, biennial or perennial, and usually have two cotyledons. The leaves usually have a bunching network of veins and the flowers have distinct petals.

FERNS are perennial and do not produce flower or seeds. Ferns consist of leaves called fronds. Ferns reproduce by long creeping rhizomes and/or by spores.

WOODY plants include shrubs, trees, and woody vines.

A 35-mm slide presentation on the identification and life cycle of about 50 weed species common to forest nuseries was included. The presentation was based on the publication:

LeBlanc, L. and K. McCully, 1991. Weed Identification Guide. Agriculture Canada, Nova Scotia Department of Agriculture and Marketing, New Brunswick Department of Agriculture, 51 p. ISBN 0-88871-171-9

3. Regional Reports

Atlantic Region

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Abstract

There are 24 forest nurseries in the Atlantic Provinces which produce 80-90 million seedlings annually. About 90% of the seedlings shipped during 1989 were container production. A total of 17 species were grown; black spruce, white spruce, and jack pine were predominant. Weeds are a major problem in forest nurseries, especially within the overwintered container stock. FUSILADE can be applied over actively growing conifers to control grass species but there are no registered broadleaf herbicidal products for forest nurseries that can be applied over actively growing conifers. The current focus of weed management in the Atlantic Region includes research with low-volume herbicides and biological control strategies, as well as education related to certification of pesticide applicators and pest management in general.

Introduction

A survey of forest nurseries in the Atlantic Region is conducted annually. The statistics contained within this report are for 1989.

There are 24 forest nurseries in the Atlantic Region. All of the forest nurseries produced container stock, while five nurseries produced bareroot stock as well as container stock. About 83 million seedlings were shipped for planting during 1989 - 91% container and 9% bareroot. A variety of conifer species were shipped, including: black spruce (51%), white spruce (17%), jack pine (13%), red pine (5%), Norway spruce (4%), balsam fir (2%), blue spruce, sitka spruce, fraser fir, eastern larch, Austrian pine, Mugho pine, Scots pine, eastern white pine, and Japanese larch.

Seventy-five percent of the container stock that was shipped during 1989 was overwintered. Overwintered seedlings usually present the greatest weed problems. This is primarily due to the fact that weed seeds can invade the holding areas and develop over a long period of time.

Various herbicides are registered for forest nursery use pattern, such as VISION, DEVRINOL, PRINCEP and FUSILADE, but there is no registered herbicide that can be applied over actively growing conifer seedlings to control broadleaf weeds. FUSILADE can be applied over actively growing conifers to control grass species. Therefore, we have weed problems in the seedbeds, transplant beds, greenhouses, and holding areas.

Research

Forestry Canada - Maritimes Region has been conducting research on weed control for several years. Environmentally controlled greenhouses were constructed at FC-MR in 1988. A pesticide spray chamber was purchased to assist in weed control research.

In 1989 and the 1990s, experiments were conducted with the herbicides GOAL, COBRA, and DEVRINOL. Treatments included four rates as well as three times of application: pre-emergence, 3-4 weeks post-emergence and 7-8 weeks post-emergence. Nine conifer species were included in the experiments - black spruce, red spruce, white spruce, Norway spruce, red pine, eastern white pine, jack pine, eastern larch, and balsam fir. Data was collected and a statistical analysis will be completed during 1991. Preliminary results indicated that DEVRINOL (2, 4 and 8 kg a.i./ha) inhibited germination and caused mortality of eastern larch. DEVRINOL also resulted in earlier bud formation of red pine which directly resulted in decreased height growth. COBRA and GOAL, at the medium and high rates, for 3-4 weeks post-emergence resulted in slight to moderate needle damage.

Liverworts can be a major problem in some container nurseries. A screening trial was conducted to evaluate various herbicides (GRAMOXONE, LONTREL, VISION, KILLEX, GOAL, COBRA, and EQUAL) for control of liverwort within the crop, as well as around the crop: Results from this trial indicated that no suitable long-term control of liverwort was achieved.

EQUAL (dodine) was used by Gwen Shrimpton, B.C. Ministry of Forests. The results of these experiments were inconsistent. An experiment was designed and conducted at FC-MR to evaluate the tolerance of nine conifer species to EQUAL (0, 1.5, 3.0, and 6.0 kg a.i./ha) at 6, 8, and 12 weeks post-emergence. No visual damage occurred. Data was collected for statistical analysis in 1991.

AGRIBROM has been used successfully in horticulture for control of algae, mosses, slime, and liverworts. An experiment was conducted with rates of 0, 10, 20, 40, and 80 ppm to evaluate the tolerance of nine conifer species. The treatments were applied weekly over a 10-week period. Preliminary results indicated that there was no damage to the conifers. It should be noted though that it is very difficult to completely dissolve AGRIBROM.

Education

Pest Management education has been an important component of technology transfer in the Atlantic Region. One-day instruction on the safe and proper use of pesticides in forest nurseries and seed orchards has been developed and implemented. The Canadian Association of Pesticide Control Officials (CAPCO) is presently developing national standards for certification of pesticide applicators. Provincial authorities are developing certification programs for pesticide applicators. FC-MR will be developing educational modules directly related to pest management (*i.e.,* pest identification, life cycles, and management strategies).

Atlantic Forest Nursery Crop Advisory Committee

The Atlantic Forest Nursery Crop Advisory Committee is compiling a current list of registered pesticide products that can be used in forest nurseries and seed orchards. This project also entails the collection of pesticide labels and Material Safety Data Sheets. A computerized data storage/retrieval system will be designed to facilitate reference to selection of pesticide products as related to pests, location, and crop species (1992).

Conclusions

The industry and provincial agencies in the Atlantic Region have identified "protection of the forest resources against pests as the most crucial problem facing them in the 1990s." The regional strategy of Forestry Canada - Maritimes Region is "to develop and implement environmentally safe and effective biological agents and integrated pest management techniques to minimize the use of chemical pesticides." Integrated weed management in forest nurseries may include the following: biological weed control (fungal pathogens, allelopathetics, bacterial pathogens, herbivorous insects, natural phytotoxin, viral plant pathogens), sanitation, cultural practices, mechanical, chemical herbicides, weeder geese, *etc.*

Ontario

Napropamide Dissipation in Ontario Forest Nursery Soils

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Napropamide is widely used in forest nurseries in Ontario for pre-emergence weed control in established conifer seedlings. It is an important herbicide because it is one of the few still available to nursery managers after a reinterpretation of pesticide regulations. We undertook this study because we were concerned about the potential for napropamide overuse and accumulation. We also wanted to know whether the present recommendation of one application per year is too conservative, and if changing the recommendation would improve weed control. One objective in this study was to determine the rate of breakdown under Ontario forest nursery conditions to determine a safe reapplication interval for napropamide. The development of a "user-friendly" model to predict napropamide residues was also an objective.

Materials and Methods

We carried out this experiment at four nurseries in Ontario: Kemptville (45^{o} 5' N, 75^{o} 40' W), St. Williams (42^{o} 45' N, 80^{o} 30' W), Swastika (48^{o} 10' N, 80^{o} 20' W), and Thunder Bay (48^{o} 20' N, 89^{o} 20' W). Climatic regimes at these locations were representative of the forest regions of Ontario, and the soils (loamy sand) were typical of those found in Ontario forest nurseries. Organic carbon and pH at the four nurseries were 3.4% and 5.9; 1.6% and 5.6; 3.5% and 5.6; and 2.75 and 4.8, respectively. Soils were kept at or near field capacity by sprinkler irrigation throughout the experiment. The herbicide was applied to newly transplanted spruce in all four locations. It was not feasible to use the same species and cultural method at each nursery, because of operational considerations. Cultural methods and species used at each location were as follows.

White spruce, *Picea glauca* (Moench) Voss, (1½+½) field transplants were used in Kemptville. This crop was sown in beds in spring and transplanted while actively growing in early June the following year. Norway spruce, *Picea abies* (L.) Karst., (1+1) field transplants were used in St. Williams. This crop was sown the previous spring, fall lifted, kept in frozen storage overwinter, and transplanted while still dormant in spring. Black spruce, *Picea mariana* (Mill.) B.S.P. (G+1) greenhouse transplants were used in Swastika. These are accelerated transplants sown in trays in the greenhouse in March and transplanted to beds in June after a hardening treatment. White spruce (2+1) field transplants were used in Thunder Bay. These are field transplants that are grown in seedbeds for 2 years and then fall lifted, frozen for storage, and then planted out in transplant beds in June.

Although these different species and types of spruce transplants may have different rates of growth and different rhizosphere attributes that may influence napropamide degradation, they were chosen because they are typical of the types of crops grown at these different nurseries, and thus any results obtained in these trials would be more meaningful.

The herbicide was applied to plots 1.2 m wide by 10 m long at a rate of 4.5 kg ai/ha with plot sprayers. Application equipment was an R&D belt-mount CO_2 pressurized plot sprayer equipped with three SS8004 TeeJet flat fan nozzles at all locations except Thunder Bay. At Thunder Bay, the napropamide was applied with a bicycle-wheeled plot sprayer, also fitted with SS8004 TeeJets. After application, the plots received 5-10 mm of overhead irrigation to incorporate the herbicide. The experiment was replicated three times at all locations except St. Williams.

Soil was sampled throughout the growing season to determine the rate of breakdown and movement within the soil profile. Ten to fifteen 2.5-cm cores were taken from each plot, broken into 0-5, 5-10, and 10-15 cm portions, combined in bulk samples, and kept frozen until analyzed for napropamide residues. Napropamide was extracted from the soil using an acetonitrile/water and chloroform/water extraction and was analyzed by capillary gas chromatography using a nitrogen selective detector.

The results of this analysis were corrected for the percent moisture in the sample. These data were transformed to their natural logarithms and, following Walker's (1974) finding that breakdown of napropamide conforms to first order kinetics, were analyzed for linear correlation with time in days following application, and growing degree days following application. Growing degree days are a measure of accumulated warmth over the growing season. The advantages of describing herbicide breakdown in terms of growing degree days are that it is a better estimator of chemical and biological activity in the soil than time alone, and it is already being routinely recorded at all Ontario nurseries.

Results

Residue results from several sampling dates were not included in these analyses. Results from the first three sampling dates of the Kemptville location were not included because a storage problem was suspected with those samples. Also at the Kemptville site, the plots were accidentally sprayed with napropamide during an operational treatment of the rest of the compartment, and so no data is included for dates beyond August 22nd, approximately 1300 growing degree days after application. At the Thunder Bay nursery, three days of heavy rain were suspected of having moved soil from the surrounding compartment, also treated with napropamide, into the plots. No residue results from days after these heavy rains were included in the analysis.

Natural logarithms of residues were inversely correlated with time expressed in growing degree days from application at all sites in the 0-5 cm zone (Pearson correlation coefficients: Kemptville, -0.714 P=0.004; St. Williams - 0.863 P=0.0003; Swastika, - 0.688 P=0.0002; Thunder Bay - 0.708 P=0.0003) but generally not in the 5-10 or 10-15 cm zones. Napropamide was present at very low levels in the latter two zones at all sites except Thunder Bay where some herbicide did leach into the lower zones. There was generally a delay from time of application before maximum residues were found. We attribute this to some herbicide being intercepted by the crop and gradually washed off by irrigation.

A linear regression of the natural logarithms of residue levels was used to determine the initial rate of application and rate of breakdown at all sites. Initial rates of application were determined to be 8.5 %g/g, 5.9 %g/g and 3.9 %g/g at St. Williams, Swastika, and Thunder

Bay, respectively, agreeing fairly well with a theoretical estimate of 6.0 %g/g based on an estimated weight of soil of 7.5×10^5 kg/ha in the 0-5 cm zone. Using this method the initial rate of application was 2.4 %g/g at the Kemptville site. This difference is attributed to losing data from the first 3 days of sampling at the Kemptville site. The slope of the regression was used to determine the rate of breakdown of napropamide at the different sites. Half lives were 385, 597, 472, and 368 growing degree days at Kemptville, St. Williams, Swastika, and Thunder Bay, respectively.

Discussion

Initial levels of herbicide were estimated by regression and found to vary from site to site. The accuracy of measuring and dividing the soil cores would determine the soil dilution and thus influence accuracy at this step. Walker *et al.* (1985) reported that photodecomposition was a major cause of napropamide breakdown when the herbicide was sprayed directly on the soil and not incorporated. Since the herbicide was incorporated with irrigation only (as per operational nursery practice) in this experiment, initial levels were influenced by the duration, intensity, and timeliness of this irrigation. We did not monitor this incorporation except to confirm that it had been done on the day of application.

Half life of napropamide varied from site to site. Walker *et al.* (1985) reported that the half life of napropamide was positively correlated with clay content and herbicide adsorption, and negatively correlated with pH. Soils used in this study were very similar in clay content, but soil organic carbon content ranged from 1.6 to 3.5 and may have influenced breakdown (Wu *et al.*, 1975), but because the high organic soils in this study were also the coldest soils, this effect was hidden by the influence of temperature on breakdown. The fastest breakdown (expressed in growing degree days) was at the nursery with the lowest soil pH, although there were no trends that were consistent through all sites.

Growing degree days are an attempt to describe accumulated heat in a way that is easy to measure and, therefore, represent total biological and chemical activity more accurately than time alone. Napropamide half life under nursery conditions was less than 600 growing degree days in all locations. Given that growing degree days vary from under 2000 per year for cold locations such as Thunder Bay or Swastika to over 3000 in Kemptville or St. Williams, the present recommendation of one application only per year is too conservative. We recommend that this recommendation be changed so that napropamide is applied no more than once per year in northern Ontario and no more than twice per year in southern Ontario where sensitive species (or a sensitive stage such as seedbeds) are to be grown the following year. In cases where tolerant crops will be grown in the following year, this could be increased. Reapplication after 1200 growing degree days should not result in any persistence problems, and should improve weed control with this herbicide over the present recommendation of once per year. A simple bioassay, such as the one described by Romanowski and Borowy (1979), could be used when reducing reapplication intervals to ensure that residues are at safe levels.

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Prairie Regional Report 1991

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Abstract

Two issues are covered within the report. One is the response by Prairie nurseries to a request to provide information to be used in the preparation of a regional report. The other is highlights from the Final Report of the Pesticide Registration Review Team's Recommendations for a Revised Federal Pest Management Regulatory System. Comments on the effects implementation of such a system would have on pesticide use in forest tree nurseries are included. RÉSUMÉ

Prairie Nurseries - Operations and Activities

Nurseries within the Prairie region were requested to provide information for the use in the preparation of this report. The request was worded as follows "please provide a few slides and a brief summary of your operation, *i.e.*, size and type of operation and the species, amount and distribution of tree material produced. Notes on special activities such as seed collection, extraction and testing and on research projects would also be of interest." Not being a major "forestry" area the list of nurseries contacted within the region only totalled twelve. The response rate was disappointing at 25 percent.

This low response rate prompted a personal assessment of the situation, two questions came to mind: Is there sufficient forestry in the Prairie region to warrant representation in a national weed management organization? Does the organization have anything worthwhile to offer its membership?

Consideration of these two questions resulted in the following conclusions: Even though termed "Prairies", significant forest occurs within the region, primarily in the north. Important reforestation nurseries are located in each of the three provinces: Pineland and Clearwater Provincial Forest Nurseries at Hadashville and The Pas, Manitoba; Big River and Prince Albert Forest Nursery at Prince Albert, Saskatchewan; and Pine Ridge Forest Nursery at Smoky Lake, Alberta. Combined capacity of these nurseries is approximately 48 million seedlings. Based on these production figures and the geographical distribution of the nurseries, it would appear that the prairie region does merit representation in a national organization like the Canadian Forest Nursery Weed Management Association (CFNWMA).

In response to the second question, the CFNWMA has done its best to provide weed control recommendations to its membership and a valuable information exchange has taken place over the past 7 years. However, its registration efforts have been frustrated by the bureaucratic process and a lack of support by the chemical manufacturers.

Highlights of the Recommended Federal Pest Management Regulatory System

Objective - Recognizing the principles of sustainability, the objective of the Pest management Act is to protect human health, safety and the environment by minimizing risks associated with pesticides, while enabling access to pest management tools, namely pest control products and other pest management strategies.

Legislation - The Pest Control Products Act and the Pest Control Products Regulations will be rewritten and entitled the Pest Management Act and the Pest Management Regulations.

The Pest Management Regulatory Agency - The legislation will establish a self-contained Pest Management Regulatory Agency. It will report directly to the Minister of Health and Welfare, but will be separate from the Department of Health and Welfare as well as from any other federal department or agency. The Agency will be responsible for all regulatory functions in the legislation, except for those assigned to the Pest Management Promotion Office, and for developing and implementing policies related to the regulation of pest control products.

The Pest Management Promotion Office - The legislation will establish the Pest Management Promotion Office, to be administered by the Minister of Agriculture. The mandate of the Pest Management Promotion Office is to support the integration of pest management with the broader goals of environmental sustainability, including the role to set targets and establish workplans for the reduction of use of pesticides in all use sectors, taking into consideration available and potential pest management strategies that are viable, and to fund research, as appropriate.

The Canadian Pest Management Advisory Council - The legislation will provide for the establishment of a multi-stakeholder advisory council to advise the Ministers of Agriculture and Health and Welfare on an ongoing basis, on policies and issues relating to the federal pest management regulatory system, and to monitor the system for efficiency and performance.

Linkages with the Provinces - Each province will be invited to appoint a Designated Provincial Representative through whom all consultations will be made. These Designated Provincial Representatives will be invited to sit on a Standing Federal/Provincial Committee. The Committee will be responsible for addressing all matters that affect federal-provincial relations on pest management regulation.

Support Program for User-requested Regulations - The Minister of Agriculture will set up a support program to assist in the development of data for User-requested Minor Use Label Expansions, User-requested Minor Use Registrations and User-requested Registrations in the agricultural sector.

Public Information and Participation - The system will incorporate extensive public access to information relating to all aspects of the regulatory system. The public will be given notification of, and opportunity for, involvement in the development of new aspects of the regulatory system.

The legislation will establish conditions that will allow for pre- and post-decision access to health, safety and environmental data. The conditions will include provisions that will ensure confidentiality of the data.

Data Protection Policy - There will be a new data protection policy incorporated into the legislation. The policy will include an exclusive use period, and will allow a generic manufacturer to enter the market by paying compensation according to a predetermined formula to existing registrants.

Policy on Formulants - The system will include a policy on formulant ingredients (historically referred to as "inerts"). The Agency will develop an up-to-date list of formulants used in Canada and categorize formulants in accordance with a specified classification scheme. The policy includes options for regulatory action on these formulants.

Registration Criteria and Data Requirements - The Regulations will list the criteria that have to be met by all products prior to registration, as well as the data requirements that registrants must submit to support an application for registration. The data requirements will be specific to product types.

Cost Recovery - The Agency will develop a cost recovery scheme, including a comprehensive list of fees payable for various submission types.

Timelines - The legislation will establish that the Agency must complete its review and make a decision on the regulatory status of a product within specified timelines. Timelines will be based on an 18-month target for new active ingredients.

Evaluation and Decision-making Process - Regulatory decisions will be made by using a risk management approach that will involve an evaluation of efficacy, risk assessment, and when appropriate, value assessment.

Products that either pose an unacceptable risk of harm to human health, safety or the environment or are not sufficiently efficacious for their intended use will not be registered.

Products that pose negligible risk of harm to human health, safety and the environment will be registered.

For products that pose neither negligible nor unacceptable risk, the regulatory decision will be based on a consideration of the totality of the evidence provided by both the risk and value assessments.

Registration Types - The system will include a variety of permit and registration types. Active ingredients, manufacturing concentrates and end-use products that have satisfied the legislated criteria will be granted full registration. End-use products will be classified as domestic or commercial products. Some commercial products will be given a restricted class designation.

Proposed Regulatory Decision Document - A Proposed Regulatory Decision Document will be prepared for all proposed registrations of new active ingredients, and for registrations that may result in substantially increased use or exposure. Certain other proposed regulatory decisions may result in the publication of a Proposed Regulatory Decision Document. These documents will be distributed to interested parties and will allow a 60-day comment period.

Appeals - The legislation will include a provision for an appeal from a decision to accept or refuse an application to register, or to cancel, suspend or maintain the registration of a pest control product.

Labelling - Labelling provisions will ensure that information necessary to ensure safe use is prominently displayed. The legislation will include appropriate aspects of the Workplace Hazardous Materials Information System (WHMIS).

The Agency will ensure the establishment of an Information Centre that would provide rapid information on the health, safety and environmental impacts of a particular product. The legislation will then provide that the appropriate phone number(s) for this service will be placed on the label.

Special Reviews - The legislation will provide for special reviews of registered or scheduled products. Special reviews may result from new information that indicates that there may be significant risk of harm to human health, safety or the environment, or that the product is no longer efficacious. These reviews may result in the cancellation or suspension of the product, or the maintenance of the registration status of the product, with or without further restrictions.

Reevaluation - The legislation will provide for a comprehensive reevaluation policy for older pesticides.

Federal-provincial Initiatives - The legislation will provide that the Agency will take a strong leadership role in establishing minimum national guidelines in cooperation with the provinces concerning matters of national interest and in promoting the implementation of these guidelines. These matters include training and licensing programs, reuse and recycling of containers, action levels for pesticides in groundwater and drinking water and product classification systems which dictates sales, packaging sizes, and application restrictions. A national database will be established to coordinate record keeping on a national basis.

Mandatory Report of Adverse Effects - Registrants will be required to report factual information that indicates that a particular pest control product may be causing unreasonable adverse effects on human health, safety or the environment.

Enforcement and Compliance - The legislation will include a comprehensive compliance strategy, with appropriate enforcement provisions.

Export Policy - The legislation will include a policy relating to the export of pest control products. Subject to an appeal provision, the international shipment of pest control products that are cancelled or suspended in order to protect human health, safety or the environment is prohibited.

Price Monitoring and Product Import Program - The legislation will allow for a price monitoring and product import program to foster agricultural pesticide pricing discipline within the Canadian market. If the price monitoring system establishes that the prices for particular products in Canada are significantly higher than in the U.S., this price difference will serve as a trigger for product import by individual farmers, subject to certain conditions. The import program is subject to all federal and provincial legislation pertaining to the importation of pest control products, and to the protection of human health, safety and the environment, including the Canadian Environmental Protection Act, WHMIS, and the Transportation of Dangerous Goods Act.

Review of the System - The legislation will provide that 5 years following the enactment of the legislation, the Canadian Pest Management Advisory Council shall conduct a comprehensive review of the new federal pest management regulatory system, including the Price Monitoring and Product Import Program.

British Columbia

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In British Columbia, there were 56 facilities producing seedlings for reforestation during the 1990 growing season. Of these, 3 are operated by the B.C. Ministry of Forests, 7 are owned and operated by Forest Company Licencees, 5 are dedicated to nursery research, and the remaining 41 are owned and operated privately. Approximately 212 million seedlings were produced: 90% in containers and 10% in bare-root. Although seventeen different species are produced, 55% of the stock is spruce and 25% is lodgepole pine.

The major weed problem in containers is liverworts especially at coastal facilities. Fireweed and sedges are sometimes present in large numbers, probably because their seeds are present in our peatmoss supply. Areas in northern B.C. have problems with aspen and cottonwood because the seeds are easily blown onto the crop.

There were no formal herbicide trials conducted at nurseries during the 1990 growing season. Trials to control liverworts using a copper coating on the container blocks were continued.

4. Copper-Treated Styrofoam Blocks for Liverwort Control

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Abstract

Liverworts can be a major problem in container production within British Columbia. Experiments were initiated in 1990 to evaluate crop tolerance and efficacy of copper-coated styroblocks. The treatments slightly decreased germination of Douglas fir and three spruce species, but significantly decreased germination of noble- and amabilis fir. There was also a slight decrease in height growth. Further research is required due to inconsistent results on the control of liverworts.

Introduction

At most coastal and some interior facilities in B.C., liverwort infestations of outdoor container-grown conifer seedlings has been a continual source of frustration for nursery personnel. Frequent irrigation and fertilizer applications, coupled with mild temperatures and high humidities provide a superb environment for liverwort establishment and growth.

In recent years, an increasing number of B.C. reforestation nurseries have been using copper to train the roots of a few conifer species, in particular, lodgepole pine. Simply, this process is accomplished by partially or completely coating the inside surface of the cavities in the styrofoam container with a formulation of copper carbonate. The idea is not new, as the horticulture industry has used this technique for years to discourage root bound plants. Alternatively, copper-based products have also been used extensively as a grounds-keeping method of killing moss and bryophytes. Therefore, based on a suggestion from one nursery manager and in an effort to provide alternatives to pesticide control measures, a trial was initiated last year to assess the effects of copper on liverwort establishment in container seedlings.

In 1990, four conifer nurseries, located in three different geographical zones of B.C., with past histories of liverwort problems were selected as trial sites. Past experience has shown that seedlings grown for two seasons (2+0) in outdoor compounds are the most vulnerable to severe liverwort infestations. Based on each nursery's sowing requests, one of the styrofoam container-manufacturers was asked to coat the upper surface of a number of blocks with the copper carbonate formulation currently used in the root training containers. Three block configurations currently used in B.C. were treated, *i.e.,* 313b, 415b, and 415c. These were sent to the individual nurseries with their regular shipment of styrofoam blocks. The copper-treated blocks were then sown along with the regular blocks as per standard nursery practices and randomly placed in the outdoor compounds.

In all, one interior Douglas-fir (415b), two true fir (both 313b) and three spruce seedlots (313b, 415b, and 415c) were sown. All but one spruce seedlot (415b) were assessed in 1990 for stem height, root collar diameter, dry stem and root weights, percent seedling germination, and liverwort infestation. In 1991, all but the two true fir seedlots have been evaluated and these will be assessed this fall.

In general, the copper treatment had little or no effect on morphological characteristics and, in all cases, the 2+0 seedlings surpassed the minimum operational standards set by the Ministry of Forests. The only exceptions were in the 415b Douglas-fir and 313b spruce. In its first year, the Douglas-fir seedlings in the copper blocks were significantly smaller than the controls, but by the second year this difference had disappeared. The 313b copper block spruce was on average 2.0 cm shorter than the regular stock but this again was still well over the minimum height requirements for this block type.

In contrast, observations on seedling germination and liverwort infestation levels have been much more variable. Over both years, the 415b Douglas-fir, 415b and 415c spruce seedlots have shown no difference in germination levels between the copper-treated and control blocks. In comparison, the 313b spruce seedlot has shown a 16.6 and 21.1% decrease in the number of seedlings per copper-treated block compared to the controls for last and this year, respectively. The biggest surprise has been with both 313b true fir seedlots, *i.e.,* noble- and amabilis fir, which have shown to date a 39 and 50% reduction in germination, respectively.

As for liverwort infestations, copper was found to significantly reduce the number and size of liverworts in two of the four nurseries. At the nursery with the 415c spruce, liverwort numbers from last year to this were reduced by 58 and 81% respectively compared to the controls. In general, the few liverworts that did establish in the copper blocks, particularly in the first growing season, were very small and did not extend beyond the cavity lip. This year, some of the cavities were found to be covered with liverwort but this was in sharp contrast to the controls which had the entire block surface covered in liverwort.

In the second nursery, the 313b spruce had few or no liverworts in the first year but by this growing season, a 24% decrease in liverwort numbers was observed in the copper blocks compared to the controls. In part, this less dramatic decrease in liverwort numbers may be attributed to the decrease in seedling germination. With a greater proportion of cavities per block empty, this situation helps to facilitate their colonization by liverworts. Unfortunately or fortunately, depending on your perspective, the other two nurseries had extremely low liverwort numbers due to changes in their cultural regimes and so the liverwort assessments were inconclusive.

In general, it would seem that copper-treated blocks may be a method of reducing liverwort infestations while not compromising the vigor of established seedlings. On the other hand, some serious effects on seedling germination were observed, especially in true firs and, therefore, more needs to be done to fine tune this pest management option. In 1991, we are in the process of evaluating three copper-treated block scenarios which may help resolve these questions. One involves blocks painted with a home-made formulation, the second and third are blocks coated by the manufacturer, but one is at half the strength of the third or original copper carbonate formulation. Unfortunately, initial results have not demonstrated the same degree of efficacy in reducing liverwort infestations as found the previous year. We will continue to monitor these treatments through next year's growing season.

5. Testing Mechanical Weeders at the G. Howard Ferguson Forest Station

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Ontario Ministry of Natural Resources

After the loss of some old (but better) herbicides in 1989, the best herbicides left failed to restrain the tidal wave of weeds that inundated the G. Howard Ferguson Forest Nursery, Kemptville, Ontario. This was more than enough incentive to come up with alternatives, including mechanical weeding.

We did not stop working on herbicide trials for new registration or minor uses, but there was no illusion that a speedy answer would come from this direction. Non-crop weed control became a top priority. The stale seedbed technique (post-emergent on early formed seedbeds) was found to be a big help to make up for weak pre-emergents in the 1+0 year.

As a bareroot nursery, there was however the option of mechanical weeding. In 1989, we successfully introduced the first **Fobro** brush hoe inter-row weeder to Ontario nurseries. It does a good job removing small weeds (less that 1 - 2 cm in diameter or height) from 75% of the bed area. It is usually best timed before a new pre-emergent herbicide round, but since the machine only works at a maximum depth of 2.5 cm, it can be used on escapees in an existent treatment without reducing herbicide effect. However, larger weeds must be hand-weeded. We also tried the Egedal inter-row cultivator/sprayer, and found the sprayer satisfactory for post-emergent sprays, but preferred the Fobro's brushing action (weeds thrown on surface) to the cultivator's burying action.

The other area for mechanical action, within tree row weeding, appears impossible at first glance. However if something could be found, the hand-weeding savings would be substantial. This approach is not unheard of in agriculture, so this was the area that was checked out. Here, we found three machines and the key in all cases was a large enough difference in size of weeds (should be small) versus crop (should be deep rooted).

a) The **Lely weeder** is a 3-point-hitch mounted mechanical weeder made up of several rows of closely spaced, inclined, 6-mm tines. The tines vibrated through the upper 2 cm of soil removing small weeds, but not displacing deeper rooted, better established crop plants. The machine is used in numerous agricultural crops including young vegetables. At Kemptville, the Lely weeder was tried at the beginning of July on new 1+1 white spruce, 1.5+1.5 white cedar, 1+0 silver maple, and 1+0 white pine. The machine did remove mostly small (less than 1-2 cm) weeds and damage to the transplant crops was minimal, but still it was felt that there was enough potential for damaging or burying trees, that the equipment had little tree nursery application.

b) **Buddingh model "C" Weeder**. This machine is an old mechanical weeder that has been used in wider spaced ornamental, vegetable, and other crops. Due to the orientation of the weeding and mulching cones (one set on either side of the row), it cannot operate in crops with less than 0.9 m between-row spacing. Consequently, one Buddingh unit was mounted on the belly (front) mount tool bar on an older model Farmall 504 tractor. The machine was set for 1-2 cm deep and driven at a fast walking speed through new poplar stool beds in August. Small weeds (less than 2-3 cm) were well controlled and the poplar stools not harmed by the rubber-tipped weeder cone fingers. The Buddingh appears to have potential for within row and inter-row weed control in wider spaced nursery crops.

c) **Bezzerides Torsion Weeder** is a weeding tool mounted on standards for a belly mount tool bar. It consists of an inclined, round, heavy steel tine with points spaced 5 cm apart for the crop to pass through. The movement of the tines through the soil causes pressure on the soil that pops small weeds out, but does not harm the deeper rooted crop. It was designed to work in our closely spaced (20 cm) six row tree crops. The 1991 trials were promising in 1+1 oak, but more work is needed on conifers.

6. Spray Technology

Brian Beaton
Maritime Farm Supply (1990) Ltd.

Sprayer technology has rapidly improved during recent years. This is primarily due to environmental concerns, operator safety, and requirements for precise and accurate application.

Spray tips are a critical component for application of pesticides. Spray tips should be checked on a regular schedule to determine if they are excessively worn. The best way to do this is to compare the flow rate of existing tips to the flow rate of a new tip of the same size and type. Spray tips should be replaced when their flow exceeds the flow of a new tip by 10%.

The material used in the construction of nozzle tips has changed drastically recently. The traditional material is brass but new materials with longer wear lives are now available: stainless steel (2-5X brass), plastic (3-8X brass), hardened stainless steel (10-20X brass), and ceramic (100-200X brass).

There are various types of nozzles:

Flat spray	- for herbicides, insecticides, and fertilizer applications
Hollow cone	- for high pressure and high volume insecticide applications in row crops
Full cone	- for high pressure and high volume insecticide application
Solid stream	- for high volume liquid fertilizer application
Large droplet hollow cone	- for use where drifting must be kept to a minimum
Flat even spray	- for band spraying
Large droplet flat spray	- used in conjunction with cone nozzle where drifting must be kept to a minimum
Off Centre Spray	- for under tree spraying
Flood Jet	- for high volume application
Large Off Centre	- used to increase effective boom spray width
Deflector	- for raising the humidity in greenhouses

The droplet size expressed as Volume Median Diameter (VMD) measured in microns varies with the type of nozzles. The spray droplet size should be related to the use pattern of the pesticide:

30-60 microns:	contact action against flying or resting insects, prone to drift.
60-120 microns:	crop spraying with contact and residual sprays against most pests and diseases, good canopy penetration.
150-250 microns:	fungicide.
125-250 microns:	crop spraying with contact and residual sprays against most pests and diseases, good deposition but possible loss of cover density.
200-350 microns:	insecticide.

200-500 microns:	for most pests and diseases especially in conditions of high temperature and low relative humidity.
400-600 microns:	other herbicides.

An excellent video, *"Focus on Nozzles"*, was presented. The video was produced by Spraying Systems Company and may be purchased from John Brooks Co. Ltd., 1280 Kamato Road, Mississauga, Ontario, L4W 1Y1.

7. Expedite Spray System

Adriaan Hovius and Dennis Vringer
Plant Products Co. Ltd. and Halifax Seed Co.

The Expedite spray system is a state-of-the-art, low volume herbicide application system. Ready-to-use, specially formulated herbicides are delivered through a battery-powered lance. Two herbicide formulations are currently available: Expedite Grass and Weed Herbicide (glyphosate) and Expedite Broadleaf Herbicide (2,4-D and MCPP). These herbicides are available in 5-L containers which are capable of covering about 0.5 ha.

The Expedite Application System has many advantages, which include ease of use (no mixing, easy to calibrate, easy to clean up), high productivity and efficiency (no need for water transportation, less retreatment compared to string trimmers), accuracy of application (calibration, visible spray, adjustable spray width, uniform droplet size, electronic paces), and worker and environmental safety (closed system, less drift, precise application rate).

The pricing (1992) for the Expedite Application System from Halifax Seed Co. Ltd. is:

Expedite System	$430
Expedite Cleaner (5 L)	$35
Expedite Grass & Weed Herbicide (glyphosate)	$135
Expedite Broadleaf Herbicide (2, 4-D and MCPP)	$98

8. Computerized Pest Control System

Brian White
Nova Scotia Department of Natural Resources

The Forest Nursery Pesticide System (**PESTS**) is a computerized decision-making system for pesticide application in forest nurseries. The computer program was developed at Dalhousie University, Halifax N.S. under contract with the Nova Scotia Department of Natural Resources (NSDNR). PESTS is currently being used in NSDNR forest nurseries.

The program has been useful but there are a few "bugs". PESTS will be available to forest nurseries upon request after the final revisions have been completed.

The Forest Nursery Pesticide System (PESTS) consists of three program modules:

1. PESTS - a knowledge-based system (programmed using the EXSYS Professional development system) which provides a list of suitable pesticides, given a specific pest, location, tree species, *etc.*

2. PCHEM - another EXSYS knowledge-based system. PCHEM presents the user with the list of pesticides chosen by PESTS. The user then selects one specific pesticide for application. The PCHEM system may also ask a few additional questions of the user in order to determine the specific use for a chemical.

3. CHEMS - a "C" program which calculates a number of factors for a specific application of the chosen chemical. The user chooses the specific crops for an application, and the specific blocks within a crop. The system then determines which blocks are eligible for an application, based on such criteria as species, location, number of applications made previously in the year, time of last application, and total amount of that chemical previously applied in that year, on the block. The system then calculates the total area, total amount of pesticide needed, and total amount of water for mixing. The user then selects a specific sprayer and the system automatically calculates the number of loads needed and the amount in each load. This and other information necessary for pesticide application is stored in a disk file that may then be printed.

9. Computerization of Expert Committee on Weeds Abstracts

R.A. (Bob) Campbell
Forestry Canada, Forest Pest Management Institute

The Expert Committee on Weeds Electronic Data Input (**ECW/EDI**) system (U2.2) is a user friendly micro-computer program. The system is menu driven and makes extensive use of contact sensitive HELP whereby help messages are available for every data field and option.

Some features of the ECW/EDI are:

1. Generation of formulated abstracts for inclusion in the annual report.

2. Data from each trial becomes part of the database used to produce summaries based on any parameter entered (*i.e.*, herbicide, weed species).

3. Database could also form the information bank of vegetation management decision support system.

The hardware and software required to use ECW/EDI are:

Computer:	Required IBM or 100% compatible
Model:	Suggested 80286 class machine or higher
Memory:	Required 640K RAM
Operating system:	English: Required MS/PC DOS (3.2-4.01) French: Required MS/PC DOS (3.3-4.01)
Monitor:	Suggested color monitor; monochrome acceptable
Hard Disk:	Required (any size) for timely disk access
Floppy Disk:	Required for data submission once entered into ECW/EDI. EDI will soon ONLY be available on HD diskettes (3.5" 1.44 MB; or 5.25" 1.2MB)
Printer:	Suggested; for printing reports; capable of printing 132 characters per line.

As with the majority of computer application, the faster the computer in terms of CPU and disk access times, the faster the application will run.

10. Chemical Weed Control Progress at Saskatchewan Government Forest Nurseries

Jonathan Matthews
Saskatchewan Parks and Renewable Resources, Forestry Branch

Abstract

There are two provincial government forest nurseries in Saskatchewan - Prince Albert and Big River. Weeds can be a major problem. Various herbicides have been used: VORLEX PLUS, VORLEX PLUS CP, and MCPA are ineffective; CASORAN has been useful in non-crop areas; GRAMOXONE has limited usage due to health risks; AMITROL-T is no longer available; GOAL looks to be the most promising herbicide but it is not registered for forest nurseries. Hand-weeding has been used, but it is difficult to attain season long control. Mechanical weeding has been successful in non-crop lands and the purchase of a precision seeder will enable mechanical weeding within crops.

Introduction

There are two government-operated forest nurseries in Saskatchewan: Prince Albert (PAN) and Big River (BRN). They have a combined land area of 271 ha, approximately 37% of which is used for actual seedling production. Both nurseries produce jack pine and white spruce seedlings for reforestation. Prince Albert also has a mandate to produce afforestation stock, including a variety of deciduous stock, grown from seed or cuttings, and several minor conifer species: Colorado spruce, Siberian larch, scots pine, and red pine. Prince Albert is also involved in container seedling production. In order to offset the increased demands for container stock, in 1988 and 1989, eight private grower contracts were allocated. These 2,100,000 seedlings, which the private sector is expected to produce, combined with nursery figures will ensure a future annual availability in excess of 3,000,000 container seedlings.

Chemical Weed Control

Three main initiatives highlight this year's activities in Saskatchewan:

1) Field tests were conducted at the Big River Nursery with two fumigants: Methyl isothiocyanate/ 1,3 dichloropropene (**Vorlex Plus**) and Methyl isothiocyanate/ 1,3 dichloro-propene/chloropicrin (**Vorlex Plus CP**). The fumigants were applied as a seedbed preparation in the fall of 1990, in the hope that horsetail (*Equisetum arvense*) development within the fields could be checked. Preliminary visual assessments, in the spring of 1991, suggest that horsetail has not been affected and will continue to be a troublesome weed at Big River.

2) Dichlobenil (**Casoron**) was applied for the first time at the Prince Albert Nursery in 1990. It was spread around two shelterbelts, over several risers, and under irrigation pipe racks. The applications consisted of two rates: 175 kg/ha and 275 kg/ha. The 175-kg/ha rate was applied in the fall of 1990, and the 275-kg/ha rate in early April of 1991. The 275-kg/ha treatments exhibited good control of quackgrass and broadleaved weeds.

The 175-kg/ha rates were not as successful at controlling quackgrass. Annual grasses were suppressed at both rates. This is an extremely promising herbicide for the nursery and will, in the future, provide weed control around risers, headlands, shelterbelts, and possibly stool beds.

3) Lorox - L (**Linuron**) proved very effective when tested over dormant 2+0 white spruce at .68 kg/ha. Slight damage was noted on smaller seedlings, but they tended to be stock that had been damaged previously by insect predation or fungal pathogens.

Amitrol - T (**Amitrole**) has been pulled from the shelves recently, as the demand for this product is not great. This will have serious repercussions on post-emergent weed control as other herbicides used at this time are damaging to flushing spruce or candling pine, but this is when portulaca (*Portulaca oleracea*) is able to establish itself as a carpet over all of the 1+0 and 2+0 fields.

Paraquat (**Gramoxone**) has been used occasionally at the Prince Albert Nursery. The danger implicit in mishandling, the demand for licensed applicators (herbicides/pesticides), and the belief that other, less dangerous, herbicides can attain the same result, has further reduced the use of this product. However, Big River Nursery personnel continue to use paraquat, as they prefer the rapid results.

MCPA (**MCPA amine**), at 2-L/ha rates, is being tested on horsetail at the Prince Albert Nursery in 1991 to determine if more than just top kill can be achieved. Horsetail reaction to MCPA amine, up until the middle of June, did not look promising.

It is difficult to mention chemical weed control without touching on Oxyfluorfen (**Goal**). This is a chemical that would have a dramatic impact on the control of all weed species in Prince Albert and Big River when and if registered, in reducing the tremendous weed seed build-up which has developed in nursery soils over preceding years.

Hand-Weeding

The restructuring of Prince Albert Nursery's cultural weed practices, in the fall of 1990 and spring of 1991, has resulted in a significant reduction in the weed problem. That is not meant to imply that satisfactory control has been attained throughout the growing period, for it has not, particularly when meristems are actively growing.

Excellent weed control was maintained in the 2+0 and 3+0 stock until the last week in June, when portulaca began to get a foothold. Having weeders walk through the fields, rather than allowing them to sit in a field and pick it clean, meant that weeds in seven to eight fields were successfully prevented from seeding, instead of half a field to a field a day as in past years. Weed proliferation has been severely curtailed within the fields as a result of this new practice. Portulaca is a problem but once all the fields are cleared of the larger weeds, the laborers return to pick it, placing it in pails instead of alleyways to prevent seeding-out in the fields. Hoeing in shelterbelts and around leaking risers has also contributed to weed control at Prince Albert.

Mechanical Weed Control

Cultivation along shelterbelts, disking of fallow fields, scuffling of pathways and constant monitoring of areas where weeds appeared ready to seed out all contributed to a greater degree of weed control in 1991. The purchase of a Silver Mountain (Summit) Precision Seeder this spring means that mechanical weed control, in 1+0 and 2+0 fields, may be a viable alternative for the nursery in the near future. Ideal spacings between rows would suggest that now is the time to move toward the development or purchasing of a shielded inter-row sprayer, or mechanical weeder.

The Prince Albert and Big River Nursery personnel have benefitted tremendously from talking with members, and listening to the various topics and ideas presented here. These meetings always appear to have a practical, as well as a stimulating intellectual, effect on those who attend. They are obviously important in adding to the store of fundamental and applied scientific knowledge without which forest nursery weed control programs, in general, would invariably deteriorate. The CFNWMA's knowledge of herbicides has, in the last decade, advanced primarily through collaborative efforts, *e.g.,* this Association's primary focus on attaining a registration - even temporary - for the use of Oxyfluorfen in Canadian forest nurseries. The concept of supporting larger scale research efforts through multi-disciplinary agencies, in order to stimulate or continue practical nursery herbicide research in Canada, is obviously productive, registrations set aside, and I hope that this particular forum, for exchanging herbicide updates, information, and results, will continue to be available in the future.

Appendix I

Minutes of 1991 Annual Executive Meeting
Canadian Forest Nursery Weed Management Association

Forestry Canada - Maritimes Region
Fredericton, N.B.
July 8, 1991

Attendance:

Lyle Alspach
Prairie Farm Rehabilitation Administration Tree Nursery
Tracy Burns
Forestry Canada - Maritimes Region
Peter Clark
N.B. Dept. Natural Resources & Energy
Michael Irvine
Ontario Ministry Natural Resources
Len Lanteigne
Forestry Canada - Maritimes Region
Jonathan Matthews
Saskatchewan Parks & Renewable Resources
Gwen Shrimpton
British Columbia Ministry of Forests

1. GOAL, GOAL, GOAL. We have been discussing this herbicidal product for about 6 years. Efficacy and crop tolerance data is complete, the economic-benefit study had been submitted but Rohm & Haas Canada Inc. has not submitted the information to Agriculture Canada-Pesticide Directorate for registration. Why not? That is a really good question, especially when there is a willing market. Shrimpton thought that if we lost DEVRINOL, then we would have a better chance for the registration of GOAL. But the real problem is the lack of interest shown by Rohm & Haas Canada Inc. If worker exposure is a problem, then Dean Thompson, Forest Pest Management Institute, is willing to assist us.

   Irvine will organize a meeting with Malcolm Stewart and Allan MacDonald, Agriculture Canada-Pesticide Directorate; Al McFadden and Peter McLeod, Rohm & Haas Canada Inc.; Craig Howard, Forest Pest Management Institute; Mike Irvine, Ontario Ministry of Natural Resources; and Len Lanteigne, Forestry Canada - Maritimes Region.

2. Various herbicides were discussed:

AWK	- Irvine has worked extensively on this product. Ciba Geigy has recently sold this product.
EDGE (ethalfluralin)	- Irvine is planning for minor use program submissions in the near future.
PYRIDATE (lentagrag)	- promising for aspen control
LONTREL (clopyralid)	- promising for tufted vetch control

RONSTAR (oxsdiazon)	- does not seem to be a very promising herbicide
LINURON	- additional work is required

3. Standardization of statistical methods was discussed. Irvine stated that there was no high priority on this but that the experimental design for GOAL in bareroot and container stock should be utilized.

4. Biological weed control is a fairly new field. Shrimpton said that she would conduct research in this area if funding was available. Dean Thompson, FPMI, should be contacted to inquire about the possibilities of using biological weed control in forest nurseries.

5. Irvine is currently involved with integrated weed management at the University of Guelph.

6. The last survey of weed problems and control practices was conducted for the 1988 growing season. Thought should be given to a new survey to update information. Alspach commented that we should improve the analysis of data.

Appendix II

Minutes of 1991 Annual Business Meeting
Canadian Forest Nursery Weed Management Association

Forestry Canada - Maritimes Region
Fredericton, N.B.
July 9, 1991

1. The meeting was called to order by Acting Chairman Jonathan Matthews (Chairman John Thompson was absent).

   Matthews introduced the panel:

Gwen Shrimpton	- British Columbia Representative
Lyle Alspach	- Prairies Representative
Mike Irvine	- Ontario Representative
Len Lanteigne	- Atlantic Representative
Roger Touchette (Absent)	- Quebec Representative
Tracy Burns	- Secretary/Treasurer
Jonathan Matthews	- Acting Chairman

2. Burns read the minutes of the 1990 business meeting in Prince Albert, Saskatchewan. Minutes were adopted as read by Matthews.

3. Mathews read Chairman's Report as prepared by Thompson.

   Letters were written to Agriculture Canada (Pesticides Directorate) about the status of AWK. The review at that time was not complete. The CFNWMA was represented at the Forestry Pesticide Caucus in Regina who presented a brief on our behalf.

   The last official communication the CFNWMA had with Rohm & Haas Canada Inc. was in October, 1990 when I was informed that Health and Welfare Canada had not cleared Oxyflorfen from its review process.

   The Proceedings for the 1990 Prince Albert meeting will not be printed until later this month. Most probably during this meeting. The good news is that the Saskatchewan Department of Parks and Renewable Resources will pay for the printing of the 100 copies. The only cost will be for mailing.

   There are still about 30 copies of the 1989 Ottawa proceedings on hand in Prince Albert.

   For future meeting and the publishing of the proceedings, I suggest that authors bring their papers with them, on disk and written using Wordperfect. It will speed up the whole process of running off the proceedings.

   My thanks to Jonathan Matthews for delivering this report, unfortunately with current restrictions on travel, only one of us could attend the Fredericton meeting.

4. Moved by Syd Lucas and seconded by Gwen Shrimpton that the Treasurer's Report (1990-91) given by the Secretary Treasurer (Matthews) be accepted as presented. Motion carried.

Treasurer's Report

April 1, 1990 to March 31, 1991

Previous Balance	(1989-90)	2003.76
	(1988-89)	217.26
		2221.02
Registration 1991 Meeting		1180.00
		3401.02
Expenses		
(publication, meeting, business related)		1213.90
Balance		**2187.12**

New Business

5. Discussion on the registration status of GOAL was hot and heavy. Lannen wants more effort on examining various avenues for registration....maybe a new chairman. Irvine explained that this topic was extensively discussed at the executive meeting (July 7, 1991). It was suggested that a meeting be organized between Craig Howard (FPMI), Malcolm Stewart (Agriculture Canada-Pesticide Directorate), Al McFadden (Rohm & Haas Canada Inc.), Alf Campbell (past-Chairman CFNWMA) and Mike Irvine (OMNR). Irvine will organize this meeting for fall 1991. Lannen suggested that a complete package be developed and presented, so that Rohm & Haas Canada Inc. and Agriculture Canada recognizes the position of forest nurseries. Shrimpton said that this would be presented. Lannen commented that we should be aggressive. Irvine said that no decision would be made at this meeting, but the process could be initiated for submission by Rohm & Haas Canada Inc. Lucas said that he was annoyed that Rohm & Haas Canada Inc. has not submitted the package on GOAL, and feels that they are just playing games with us. Shrimpton said that the Regional Representatives are trying to do their best. Motion by Lucas and seconded by Lannen that the CFNWMA pursue the GOAL issue aggressively and quickly in order to receive a commitment from Rohm & Haas Canada Inc. and Agriculture Canada for a rapid decision. Motion carried.

6. Lucas wanted to know how many members there were within CFNWMA. Matthews replied that there were about 25. Motion by Lucas and seconded by Irvine that the CFNWMA should be promoted through news letters and mailings to all forest nurseries within Canada. Lannen said that he would assist in the French translation.

7. Motion - Shrimpton. Proceedings should be stored at FC-MR with Lanteigne and Burns.
   Seconded - Alspach.
   Motion carried.

8. Motion - Lucas. Newsletter be mailed in Jan.-Feb. prior to annual meeting.
   Seconded - Lanteigne.
   Motion carried.

   Lanteigne asked Shrimpton if she could have the dates and location for 1992 meeting.

   Clark commented that the annual report should be completed and distributed earlier. Matthews said that individuals presenting information at the annual meeting should be more prompt in the submission of written material.

9. Motion - Lanteigne. Constitutional change 2.1a) To encourage a wider understanding of the problems of weed management in forest nurseries and shelterbelt nurseries.
   Seconded - Alspach.
   Motion carried.

10. Motion - Lanteigne. Constitutional change 2.1b) To advance the members in their knowledge of weed science.
    Seconded - Burns.
    Motion carried.

11. Motion - Lanteigne. constitutional change 2.1c) To promote public interest in and knowledge of sound forest and shelterbelt nursery weed management practices.
    Seconded - Shrimpton.
    Motion carried.

12. Motion - Lanteigne. Constitutional change 2.1d) To initiate, design, plan, develop, and conduct national nursery research trials on products that are promising for weed management in forest and shelterbelt nurseries in order that sufficient data might be collected to allow for registration of these products in Canada.
    Seconded - Lannen.
    Amended - Irvine.
    Seconded - Burns.
    Motion Carried.

13. Motion - Lanteigne. Constitutional change 2.1e) To promote the development of integrated weed management systems utilizing all available techniques.
    Seconded - Burns.
    Motion carried.

14. Motion - Lanteigne. Constitutional change 4.1. Membership of the Association shall be comprised of representatives from provincial and federal agencies, industry, and private forest or shelter belt nurseries that are interested in promoting increased understanding and registration of weed control products.
    Seconded - Clark.
    Motion carried.

15. Motion - Irvine. Suggested that a representative from Pesticide Directorate be invited to annual meetings.

Seconded - Burns.
Discussion - Shrimpton asked if a regional representative would be satisfactory but Irvine thought that an individual from Headquarters would be more beneficial.
Motion carried.

16. Motion - Matthews. Letter be sent to John Thompson and his group for hosting last year's meeting as well as a letter to Clark, Burns, and Lanteigne for 1991 meeting.
Seconded - Lucas.
Motion carried.

17. Motion - Lucas. Regional representatives remain as previous year.
Seconded - Clark.
Discussion - All regional representatives present at the meeting accepted. Consult with Roger Touchette, Quebec Region on his acceptance.
Motion passed.

18. Motion - Lucas. Registration status be reported annually by the Association.
Seconded - Lannen.
Motion carried.

19. Shrimpton suggested British Columbia for 1992 meeting. The 1993 meeting could possibly be in Quebec.

Appendix III

List of Participants
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July 8-9, 1991

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