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Contents

Tree planter exposure to fertilizers and pesticides

Abstract

The study investigated self-reported health effects among 223 tree planters at 13 sites in British Columbia and western Alberta, and measured personal exposure to fertilizer dust, heavy metals, and certain pesticides among a subgroup of 54. The study identified an association between chronic respiratory symptoms (cough, phlegm, and nasal symptoms), nosebleed, and skin irritation, and duration of work with fertilizers among tree planters. Overall, among the 54 individuals examined, measured exposures to heavy metals and dust were low. Pesticide exposure was also low, but residues found on seedlings and skin samples demonstrate a potential route of exposure. Opportunities exist for fairly straightforward improvements to hygiene conditions and dermal protection (i.e., glove) programs that would reduce the risk of exposure.

Keywords:

Metals, Pesticides, Fertilizers, Dust, Tree planters, Exposure, Health effects, Safety.

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Introduction

Since 1988, tree planters have planted more than 5 billion seedlings in British Columbia, covering over 150 000 hectares per year. In British Columbia alone, there are 100–200 independent contractors that hire in excess of 5000 seasonal workers annually. Worksites are typically remote and geographically dispersed, with a planting season that starts in late January–early February in the coastal areas and progresses inland to the peak spring planting period in May and June. This is followed by smaller summer and fall planting operations.

To increase early growth of seedlings, fertilizing is done at time of planting in some areas. Fertilizer, contained in a sachet or "tea bag", is inserted in the soil close to the seedling. Several factors in the work environment may influence tree planter exposure to these fertilizers:

- Limited washing facilities create fewer opportunities for hand and face washing prior to eating, drinking, or smoking. Reduced hygiene increases the risk of chemical exposure pathways via ingestion and dermal (skin) absorption.
- Planters are less likely to use gloves and dust masks because of discomfort during strenuous work in hot environments, unless mandated by their employers.
- Tree planting is done on piecework; this can be a barrier to proper health if safe practice reduces productivity and income.
- The heavy exertion by tree planters increases inhalation rates and airborne exposure.
- The physically harsh environment often leads to wounds and lesions on the skin that can potentially enhance dermal uptake of hazardous chemicals.

While forest tree nurseries strive to use as few pesticides as possible, there are times in the growing and storing phases when it becomes necessary to use them to protect the crop. Seedlings not going into storage are less likely to need any pesticide treatment and many are now shipped as pesticide-free seedlings.

Concerns among the tree planter community about planters' exposure to fertilizers and pesticides prompted this study. This report is a summary of an M.Sc. thesis (Gorman 2008) and a contract report (Davies et al. 2009).

Research problem

Exposure to fertilizers at time of planting

Tree seedlings planted in certain parts of British Columbia are fertilized at time of planting using fertilizer tea bags. The fertilizer comprises phosphorous, potassium, and nitrogen, which are typically present as phosphoric acid, potash, and urea or ammonium nitrate, plus elemental nutrients such as boron, copper, and manganese. The composition of the fertilizers is selected to provide a blend customized to the needs of the crop and site conditions.

When an area is to be fertilized, tree planters are required to insert a tea bag into the soil near each planted seedling. Planters carry the fertilizer in hip bags or containers (Figure 1) that can hold several hundred tea bags. Exposure to fertilizer dust may occur with repeated handling of the tea bags, if tea bags break, and when opening the fertilizer shipping bags and containers.

Tree planting is carried out in all types of weather conditions. Although the fertilizers are polymer-coated, the coating is degraded when the granules become wet. This means that planters' hands can come in contact with wet fertilizer and are potentially exposed to ammonia and phosphoric acid. Opportunities for hand washing after contact with fertilizers are limited. Inhalation of gas released by wet fertilizer granules is also a possibility. Concerns regarding health effects of exposure to fertilizers have been expressed by both planters and contractors experiencing skin rashes, nausea, headaches, nosebleeds, congestion, eye irritations, and respiratory ailments.

Exposure to possible heavy metal contamination of fertilizers

Fertilizers may contain non-essential heavy metals as contaminants. Phosphate fertilizers are manufactured from phosphate ore that may contain naturally occurring heavy metals, especially cadmium. While the Canadian Food Inspection Agency requires that all micronutrients are listed on the product labels, it does not require labelling of non-essential metals. Registration of phosphate fertilizers is not required. Arsenic, cadmium, and nickel are all confirmed or suspected human carcinogens; these and other heavy metals, including lead, also have other important non-malignant health effects. Cadmium is particularly hazardous as it remains in the body for a long time.

Exposure to pesticides

While planters do not apply pesticides, they are potentially exposed to them if seedlings have previously been treated and there are residual chemicals. Pesticides are applied in nurseries prior to storage, usually as part of an integrated pest management program, and targeted to a specific pest or fungus. Seedlings are typically stored over the winter at -2°C for planting in the spring, while seedlings planted in the summer are hot-lifted immediately prior to planting. Seedling storage length and conditions may affect the retention of residual chemicals. The nurseries document pesticide applications and the analysis in this study targeted those pesticides known to have been applied.

Study objectives

- Determine if tree planters in British Columbia are exposed to fertilizer dust, heavy metal contaminants of fertilizers, and pesticides. If so, at what levels?
- Determine the prevalence of adverse health outcomes, and how they compare to other populations.

Methodology

Study population and subject questionnaire

A total of 223 tree planters at 13 tree planting operations in British Columbia and Alberta volunteered to participate in this study, carried out in 2006–2007. Five British Columbia operations were selected for in-depth personal exposure monitoring—two on the coast and three in the interior, with one of the interior operations used as the control because it did not use fertilizers. Blood samples from another ten subjects were obtained from university students with no tree planting experience.

A health and exposure history interview was administered to participating tree planters by trained interviewers. The standardized questions on respiratory health were designed to provide a measure of current symptoms and how long they had been present. The analyses were adjusted for age, gender, cigarette smoking, amount smoked, and childhood asthma. Regression analysis was applied to take account of potential confounders.

Personal exposure monitoring

Fifty-four tree planters carried air sampling units to collect inhalable dust (Figure 2). Trained medical staff took blood samples from the same population, and the investigator obtained three skin-wipes per subject (Figure 3). Bulk samples of fertilizers were obtained from the manufacturers and a leachate was analyzed for heavy metals. Surface soil and the soil in the root balls were also analyzed for heavy metals. Seedling stems and foliage were analyzed for pesticide residues. All analyses were carried out by a commercial laboratory according to established standard methods.

Figure 1. One type of container holding fertilizer “tea bags”.

Figure 2. Nozzle for sampling dust inhalation by planter.

Figure 3. Wiping skin for chemicals.

Results

The mean age of the 54 planters that took part in the exposure monitoring study was 28.4 years, and ranged from 21 to 58 years. The average number of years of planting experience was 7.4 years, and ranged from 1 to 29 years. Approximately one-third were females.

Fertilizers

Dust

The fertilizers used in the study came from two suppliers. The products supplied by Reforestation Technologies International were Planters Pak™ custom blend (18-10-10) and Silva Pak™ (26-12-6). Those from Spectrum Pacific Products Inc. were Defender™, which includes 10% sulphur, and Forest Pro™ (26-9-9).

Useable samples of the inhalable particle fraction of airborne dust were obtained for 33 subjects at fertilizing locations. The mean amount inhaled was 1 mg/m³, ranging from a low of 0.39 (which is the limit of detection) to 5.3 mg/m³, while for 9 subjects at the non-fertilizing site the average was 1.4 mg/m³, with a range of 0.39–3.0 mg/m³. Airborne dust analysis measures all dust in the air, and cannot discriminate fertilizer dust from other particles.

Metals in air and blood, on the skin, and in the environment

Overall, concentrations of airborne metals were very low. Only 17% of samples obtained had detectable levels of the metals examined: lead at one site, nickel at two sites, and chromium at three sites. All exposures were below the British Columbia regulatory limits for airborne exposures which are 10 µg/m³ for arsenic, cadmium, and chromium, and 50 µg/m³ for nickel and lead. There were no large differences in the levels found at any of the sites, and for at least one metal (nickel), airborne levels were higher at the site not using fertilizer than at other sites.

Levels of metals in blood were generally very low. Few measurements were above the limit of detection (0.02 µg/g). The highest number of samples with detectable levels of metals was at the control site. Where levels of metals were above the limit of detection, however, concentrations were similar across sites. Lead, the most commonly found contaminant, was found in 40% of all blood samples. Levels ranged from below the limit of detection to 0.1 µg/g. At the high end, blood-lead levels were 10 µg/100 mL (assuming a specific gravity of blood of approximately 1.05). The American Conference of Governmental Industrial Hygienists (ACGIH) recommends that levels be kept below 10 µg/100 mL for women of child-bearing potential because of the increased risk of delivering a child with a higher-than-normal blood-lead level which increases the risk of cognitive deficits in the child. One female planter, aged 23, had a blood-lead level of 10 µg/100 mL. She was working in her first year of tree planting and on her first contract, however, and was working at the control site where no fertilizers were being used; she had previously worked as a painter.

Three planters had blood-cadmium levels that exceeded the recommended maximum level of 5 µg/L (one male and two females, ages 23 to 26). Two of these planters (levels of 5 and 7 µg/L) were working at the control site where no fertilizers were being used; both were on their first contract and had never worked with fertilizer. The third planter (level of 6 µg/L) had planted for nine years, and worked with fertilizer approximately 90 days over the prior two years. All three planters were smokers; the ACGIH notes that smoking is a significant source of cadmium exposure and median blood levels of smokers is 1.4 (females) and 4.5 µg/L (males).

Arsenic and cadmium were found at detectable levels in five skin-wipes, but all of these were low and at the limit of detection. Chromium (0.5–15.7 ng/cm^2), nickel (0.8–8.0 ng/cm^2), and lead (0.3–31.6 ng/cm^2) were more commonly found. Mean levels at the control site were second-lowest for chromium, but second-highest for lead and nickel, while the ranges for all three metals were similar across the five sites.

Traces of all the metals were found in both bulk soil samples from the tree planting sites and in the soil within the seedlings' root-ball. Detectable amounts were also found in leachate of the various fertilizers, i.e., arsenic (0.016–0.027 mg/L), cadmium (0.0009–0.0021 mg/L), chromium (0.13–0.26 mg/L), nickel (0.099–0.16 mg/L), and lead (<0.001 mg/L).

Mean skin exposure levels for chromium, nickel, and lead were compared to environmental levels obtained from soil samples, root balls, and bulk fertilizer leachate for each site, but it is difficult to interpret the possible source of the metals found on skin samples.

Pesticides

Pesticide-treated seedlings were planted at all five sites where personal monitoring was conducted. We focused on analyzing skin samples for compounds reported as being used by the forest nursery that had supplied the seedlings. Pesticide residues were detectable only at two sites. At one site, chlorothalonil and iprodione (trade names include Daconil and Rovral, respectively) were found on the majority of skin samples, while at the other site, chlorothalonil was found on 9 out of 10 samples but iprodione on only a single sample. Where detected, chlorothalonil levels ranged from 0.37 to 106.3 ng/cm^2 of skin, and iprodione levels ranged from 0.7 to 15.9 ng/cm^2 of skin. While relatively low levels, these data demonstrate that pesticide residues are being transferred to workers' hands and arms from treated seedlings. Potential for exposure then occurs through dermal absorption, which is likely quite low, but also ingestion if proper hygiene precautions are not taken.

Pesticide residues were found on a large number of seedlings tested at variable concentrations, but as high as 1000 ppm for chlorothalonil. Levels were higher for seedlings sampled during the earlier coastal planting period (April), while samples from the later interior planting period (May/June) showed much lower levels.

There were inconsistencies between nursery records and chemical analyses. For example, one seedlot only indicated chlorothalonil being used, but iprodione was also found on the sample. Similarly, chlorothalonil and captan were found where they were not indicated. In one case, cypermethrin was indicated on nursery records, but the seedling box was marked pesticide-free.

Self-reported health impacts

Of the 223 planters that took part in the health impact study, 154 had been exposed to fertilizers in the past two years and 69 had not. The overall mean age was 26.4 years, but those with fertilizer exposure were about three years older than the mean and those without fertilizer exposure were three years younger. Females made up one-third of the groups. The fertilizer-exposed group had an average experience of 6.6 years versus 3.3 years for the non-exposed group.

The analyses were adjusted for sex, age, smoking, and childhood asthma. Marijuana smoking data were collected but it was not related to the health effects seen and was not included in the regression models.

Four work-related[1] symptoms had prevalence greater than 10%. Work-related nasal symptoms, including sneezing and stuffy nose, had a prevalence of 36%. Work-related phlegm, cough, and skin symptoms had prevalence of 16%, 14%, and 11%, respectively. Work-related cough, phlegm, wheeze, nosebleed, eye irritation, and skin symptoms were more prevalent in the fertilizer-exposed group than in the unexposed group (Table 1). Only work-related nasal symptoms were less prevalent in the exposed group.

Table 1. Overall and work-related symptom prevalence of tree planters participating in this study, based on interviews results

Symptom	Total number of respondents providing information[a]	Both exposed and unexposed		Fertilizer exposed		Fertilizer unexposed	
		no.	%	no.	%	no.	%
No. respondents	223			154		69	
Any cough	223	79	35	61	40	18	26
Any phlegm	223	88	39	58	38	30	43
Occasional wheeze	221	68	31	46	30	22	32
Any chest tightness	222	27	12	15	10	12	18
Any nasal symptoms	223	154	69	114	74	42	61
Any nosebleed	223	60	27	45	29	15	22
Any eye irritation	223	27	12	19	12	8	12
Any skin symptoms	222	43	19	36	24	7	10
Work-related							
Work-related cough	216	31	14	23	16	8	12
Work-related phlegm	215	34	16	25	17	9	14
Work-related wheeze	216	19	9	15	10	4	6
Work-related chest tightness	220	3	1	2	1	1	1
Work-related nasal symptoms	216	78	36	56	30	22	32
Work-related nosebleed	223	21	9	17	11	4	6
Work-related eye irritation	222	14	6	11	7	3	4
Work-related skin symptoms	220	25	11	21	14	4	6

[a] Sample sizes less than 223 are reported for some symptoms because of missing information.

1. Symptoms were defined as “work-related” if the subject reported that: i) the symptom was usually present, ii) the symptom improved on days off or during the non-planting season, iii) the symptom was aggravated by work-related activities (e.g., general work environment, work with fertilizers, work with pesticides, and dust), and iv) the symptom was absent prior to the commencement of work as a tree planter.

Figure 4 shows that, although not statistically significant most of the time, the "trend" of increasing risk for symptoms increases with longer exposure.

Personal protective equipment use

Gloves were the principal method of personal protection against chemical exposure used by tree planters. Table 2 lists self-reported glove use on the seedling hand. A reasonable chemical barrier might be assumed for nitrile, latex, and even dishwashing gloves, but cotton and gardening gloves, even if partially rubberized, will not offer chemical protection. Gardening and cotton gloves were used by the majority of planters interviewed.

Table 2. Personal protective equipment used by 54 study participants

Glove type	Frequency of use (%)
Gardening style glove	57.4
Thick[a] solvent glove (nitrile, neoprene, or rubber) only, or over cotton glove	18.5
Thin[b] nitrile or latex glove under cotton or gardening glove	11.1
Cotton glove only	1.9
Dishwashing glove only	5.6

[a] Thick gloves defined here as ≥0.3 mm.
[b] Thin gloves defined here as <0.3 mm.

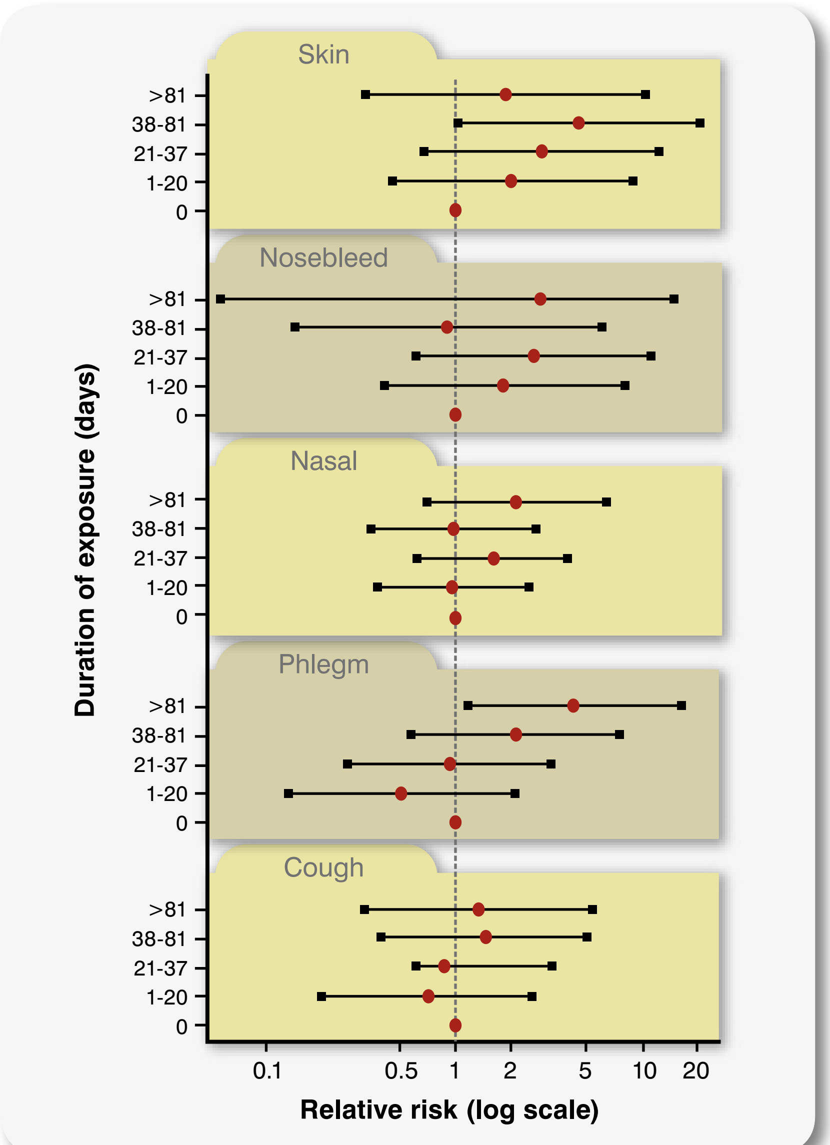

Figure 4. Relative risk of five health symptoms at different exposure levels, with 95% confidence intervals. Relative risk is a ratio of the probability of the event occurring in the exposed group versus a non-exposed group (1 = no difference).

Discussion

Fertilizer and heavy metal exposure

There was no apparent evidence linking increased exposure to the heavy metals investigated (arsenic, cadmium, chromium, nickel, and lead) and work with fertilizers. When treating the dust exposure as "particles not otherwise classified", and assuming the particles are benign (which is not known), all exposures complied with permissible exposure concentrations prescribed by the Workers' Compensation Act regulation for British Columbia. As well, all airborne exposure levels for potentially contaminating heavy metals were below their respective regulatory limits. There were no large differences in the levels of metals in air found at any of the sites, and for at least one metal, nickel, airborne levels were higher at the site not using fertilizer than at other sites.

There are no regulatory levels for dermal exposure to metals. Data from skin swab tests were compared across sites to examine whether dermal exposure to heavy metals was greater among sites using fertilizer than the control site where fertilizers were not being applied. There was no consistent association between the use of fertilizer and elevated levels of heavy metal dermal exposure.

Levels of metals in blood were generally very low. One female subject had a blood-lead level at the recommended maximum for females of child-bearing age, but she had no planting work experience using fertilizers. Three subjects had blood-chromium levels above the recommended maximum, but two of these had never planted using fertilizer, and all were smokers; smoking is known to increase blood-cadmium levels into the range seen in these individuals. The highest number of blood samples with detectable levels of metals was at the control site, and where concentrations of metals were above the limit of detection, concentrations were similar across all sites.

Pesticide exposure

Pesticide residues were found on many of the seedlings examined, and were higher for those tested earlier in the planting year. This demonstrates the potential for exposure, particularly earlier in the planting year before residue levels have decayed sufficiently. Pesticide residues were found in tree planter skin swab tests taken at two coastal sites in April. It is difficult to interpret the specific health risk posed by the levels found, but at least one of the agents used, chlorothalonil, is in a group possibly carcinogenic to humans. It again demonstrates the potential for exposure, either by dermal absorption or by ingestion, if adequate hygiene precautions are not taken.

Health effects

The prevalence of respiratory symptoms was higher than would be expected for a young and fit group such as tree planters. The results of this study were compared to the results from two other groups of British Columbia workers—ferry workers and entertainment industry workers—exposed to respiratory irritants and interviewed using the same respiratory health questions used in this study.

The average ages of the ferry and entertainment industry workers were greater than that of the tree planters. There were similar proportions of females among all three groups. Although the proportion of current smokers was highest among tree planters, tree planters had the lowest proportion of former smokers and amount smoked, measured in number of cigarette packs smoked per year.

When compared to the ferry workers, excluding those with significant asbestos exposure, tree planters had a higher overall prevalence of cough, phlegm, and nasal symptoms. Tree planters also had higher prevalence of cough and phlegm than entertainment industry workers who are exposed to theatrical smokes and fogs. The fact that tree planters, the youngest group, had the highest prevalence of cough and phlegm among the three groups is surprising. This demonstrates that further investigation of chemical exposures among tree planters is warranted so that factors such as outdoor living, and work in cold, dusty, or hot environments that may have a contributing effect, can be eliminated.

The exposure response analyses shown in this study suggest that the high prevalence of respiratory symptoms may be related to working with fertilizer, although there are other exposures that tree planters may be subject to which could also contribute to respiratory symptoms. These include exposure to pesticide residues, dust, and working and living in the outdoors. Tree planters are less likely to recall pesticide and dust exposure than fertilizer exposure, so this study did not try to obtain self-reported historic data on these exposures.

The health effects that were seen to be related to fertilizer use may be caused by irritant constituents of fertilizer including phosphoric acid and the nitrogenous components of fertilizer which likely release ammonia. These irritants were not measured in this study so it is difficult to describe the relationship between them and the health effects that were seen. Although individual estimates were not statistically significant, the results of the exposure response analyses suggest that work with fertilizer is associated with increased odds of chronic cough, phlegm, nosebleed, and dermal irritation. The trend is not consistently increasing, which may suggest the following: the effect of exposure may plateau; a healthy worker survivor effect whereby exposed workers who experience symptoms leave the industry; or workers become acclimatized to fertilizer exposure and skin irritation diminishes with increasing duration of exposure.

Personal protective equipment use and hygiene practice

The majority of tree planters in this study used only gardening gloves which do not provide a full chemical barrier. In fact, because these glove materials can absorb and retain liquids and dusts, they may increase exposure over time as chemicals become trapped and are held against the skin. Adequate personal protective equipment programs must include provisions for replacing and cleaning protective clothing like gloves, as well as training how to select, wear, and remove such equipment. Considering that exposure potential was demonstrated, the extreme work environment (physiological demands, poor hygiene options, production pressure, variable weather conditions), and the transient nature of the workforce (hard to follow up and determine chronic impact of exposures, or even if poor health is a factor in selecting tree planting as a work option), this is one area that would benefit from immediate improvement, along with improved hygiene facilities.

Strengths and limitations of the study

This study is the first to examine heavy metal exposure among tree planters, and the largest to date to examine pesticide residue exposure in this occupational group. Although the subjects were working at five different geographic regions and in different seasons, the study still represented only a few of the many different permutations of region/climate/weather/tree species/fertilizer types to be found. The composition and sources of fertilizers will also change over time, as will the need for pesticide use depending on growers' nursery conditions. The results are valid for the conditions examined but care must be taken in extrapolating more widely.

Some of the study limitations may have impacted the outcome of the study. For example, the exposure measure (days of fertilizer use) only included the previous two years. Although no information about earlier exposures was collected, it is likely that at least some workers were exposed during this time and those exposures may contribute to their current symptoms, particularly if sensitization has occurred.

Many of the tree planters in the reference group performed most or all of their planting work in Ontario where fertilizer is not used so it is unlikely that there are many subjects in the reference group with extensive fertilizer exposure over the two years prior to participating in this study.

Another source of potential misclassification was the method of calculating the number of days of exposure. Each planter was asked the length of each contract over the past two years where fertilizer was used. However, fertilizer may not have been used on every day of these contracts so the number of days of exposure may be overestimated for some subjects.

The exposure was self-reported, which may have contributed to further exposure misclassification if subjects did not accurately recall their exposure. Self-reported exposures may be influenced by a differential recall bias whereby subjects who experience symptoms are more likely to recall exposures than those without symptoms. However, recall bias is thought to be minimal for the two-year recall period. Despite sources of potential errors which could lower the relative risks estimates, a trend for increases in the relative risks was seen with increasing exposure.

Our investigation of pesticide exposure was strengthened by targeting the analysis to compounds known to have been applied to the seedlings being handled, and it allowed us to look at a broader range of chemicals than is usually possible without a large budget.

Directions for a future study

To better understand the exposures to metals, dust, and pesticides among tree planters, further sampling is necessary. Notable omissions from the current study include northern British Columbia; the late summer/autumn portion of the tree planting season; and exposures to mercury, ammonia, and other irritant components of fertilizer. Subsequent sampling could address these omissions. Sites in the southern interior and coastal regions should also be sampled and the spring/early summer period should be included to allow comparison of the results from the current study to exposures in other years and seasons. Further sampling would allow better generalization about exposures experienced by tree planters in British Columbia.

In this study, pesticide residues were found on seedlings and on the skin of tree planters during spring coastal planting in 2007 but not during late spring/early summer interior planting in 2006. Insufficient seedling samples were taken to fully explain the reason for these findings. Future work could collect seedlings from a wider range of nurseries representing coastal, southern interior, and northern regions; during different years; and throughout the tree planting season (i.e., early spring, late spring, early summer, late summer, and autumn). Partnerships between researchers and nurseries could ensure that sufficient information is collected to understand the factors that contribute to pesticide residues remaining on seedlings at the time of planting.

A limitation of this study was that the wording of the health questionnaire was not ideal for capturing health effects related to seasonal employment. The work-related symptoms of some subjects may therefore not have been captured. Subsequent questionnaires should try to collect information on the seasonal employment experience of these subjects.

Discussions with tree planters during field work and knowledge transfer activities indicated that tree planters are concerned about the long-term health effects of tree planting work, particularly physiological strain on the body and cancer related to pesticide exposure. The current study did not examine the long-term health effects of tree planting work. Future work should examine the health of ex-tree planters to determine whether there are any long-term health implications of tree planting work, including the long-term implications of pesticide and fertilizer exposure among tree planters.

Implementation

It is recommended that tree planters implement the following practices in their work to reduce their exposure to fertilizers and pesticides:

- Open boxes of trees and boxes of fertilizers in well-ventilated areas and avoid inhaling vapours from newly opened boxes.
- Immediately clean up any fertilizer spills, and do not leave loose fertilizer or broken tea bags in planting bags. They will fall onto other people's gear during transport.
- Occasionally clean planting bags with water to help remove any chemical build-up.
- Carry tea bags in a special fertilizer pouch, plastic bag, or customized container. Carrying them loose in canvas planting bags or Silvicool bags does not offer effective containment.
- If using a 4-litre milk jug with a hole just big enough to fit a closed hand through to carry tea bags, as is common with tree planters, line the edges of the hole with duct tape, and hang the jug from the planting bag belt. The plastic will prevent wet fertilizer granules from leaching through the clothing.
- Wash hands with soap and water after handling fertilizer or pesticides. Alcohol-based cleaners and disposable hand wipes are meant for killing germs, and are not effective for removing chemicals.
- Remove gloves used for planting before eating, drinking, or smoking.
- Wash hands before eating, drinking, or smoking.
- Take a small bottle of biodegradable soap to work each day, and use a small bottle of water or a camping water jug to wash hands.
- Use planting gloves made of nitrile. Butyl rubber and neoprene gloves offer good chemical protection but are not usually flexible or thin enough for planting purposes. Latex rubber gloves are not suitable for planting. They are a reasonable chemical barrier but not effective against some chemicals.
- Bring several pairs of gloves to use during the day.
- Ensure the planting gloves fit well and do not compress the knuckles or hand tendons which could promote tendonitis.

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— Ernst Stjernberg

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