Patterns of herbicide usage by cereal crop farmers in Western Australia

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Summary

Changed farming methods have resulted in increased use of chemicals by the farming community. This has, in turn, led to expressions of concern regarding possible adverse effects on the health of farmers. Our survey indicates the types and quantities of chemicals being used on cereal farms in Western Australia. The results indicate that some misunderstanding exists about the safe use of chemicals and that farm workers need further education on the proper use of chemicals.

Introduction

Especially since the Second World War, methods of tillage in cereal cropping have been changed by the use of modern machinery coupled with the development and increasing use of pre- and post-emergent herbicides. With this has come the hazards of exposure to herbicides and concern about potential long-term effects on health.

Epidemiological studies have found elevated rates of cancer in workers exposed to agricultural chemicals (Axelson and Sundell 1974; Hardell and Sandstrom 1979; Axelson *et al.* 1980; Barthel 1981; Eriksson *et al.* 1981; Hardell *et al.* 1981; Hardell *et al.* 1982). Studies conducted in the United States to investigate the causes of death among agricultural workers found elevated rates of leukemia, soft-tissue cancers and other chronic diseases among agricultural workers when compared to death from these diseases in the population as a whole (Blair and Thomas 1979; Agu *et al.* 1980; Burmeister 1981; Burmeister *et al.* 1982; Cantor 1982; Burmeister *et al.* 1983; Balarajan and Acheson 1984; Buesching and Wollstadt 1984; Cantor and Blair 1984). These studies were based upon hospital records, death certificates and cancer registry information; hence the subjects were often deceased before the study commenced. Any information on farming practices and possible chemical exposure would have been obtained from next of kin, and therefore liable to memory bias. A review of these studies has been published by Sharp and Eskenazi (1986).

Individually, most of the previous studies have suggested that either agriculture, as an occupation, or exposure to agricultural chemicals may be linked to cancer or chronic disease but none of the studies has shown this conclusively. However, collectively these studies imply that it would be wise to monitor very closely the use of agricultural chemicals and their potential adverse effects on health.

The aim of this study is to determine if any long-term health effects are associated with the use of herbicides and other agricultural pesticides and to identify the nature of the effects and magnitude of the risk they present to cereal farmers.

Material and methods

A sample of cereal farmers in Western Australia was surveyed in 1984–85 by postal questionnaire to collect base-line data on their usage of herbicides, and other agricultural pesticides, methods of application and the use of protective equipment.

Cereal farmers were chosen for the study because herbicides were more widely used by cereal farmers than those in most other types of agriculture. If adverse effects on health are associated with herbicide use, then they should manifest earlier and/or more severely in this population. Moreover, cereal farmers comprise a large group and thus a study of this population can be expected to provide sufficient power to detect such risks should they exist.

Based on the survey data each farmer was classified into one of four exposure groups: non users, low, moderate or high usage.

It was not feasible or desirable to produce an exact measure of exposure to herbicides for each farmer. The approach taken was to evaluate potential for exposure. This was achieved by gathering information on herbicide usage and farm practices. The amount and type of herbicide used was the main factor in exposure classification together with the use of protective clothing and method of mixing chemicals.

The health of farmers and family members in each exposure group is being evaluated over a 5-year period. If exposure to herbicides or other agricultural pesticide is a risk factor for cancer or chronic disease, then elevated disease rates should be found in those farmers in the higher exposure groups.

This paper presents information on herbicide and other agricultural pesticide usage only and incorporates data on farm practices associated with herbicide use.

Piloting of the survey questionnaire indicated that cereal farmers generally identified herbicides and other pesticides solely by their proprietary brand names. In the following tables, herbicides are listed by active ingredients, but the information was collected by using trade names.

Results

A total of 2921 cereal farmers responded to the postal survey. Assuming one farmer per property, this represents 35.7% of the 8178 cereal-producing properties in Western Australia.

Farm location and size

Of the farmers responding, 89% were from the Southern, Eastern and Central Coastal regions of Western Australia with the remainder from smaller cereal-producing regions of the State. Of cereal producers, 23.8% had farms of less than 1000 ha and 38.1% had farms larger than 2000 ha. Comparison of farm locations and farm size of the study participants with that of all cereal properties in Western Australia (Australian Bureau of Statistics 1985) suggests that the participants are a representative sample.

Herbicide usage

Herbicides were used by 88.6% of respondents; 5.6% claimed that no herbicides were used on their property, and the remaining 5.8% did not indicate whether herbicides were used or not. Because of the open-ended design of the questionnaire, many of the remaining 5.8% who did not

Table 1 Number of herbicides used

No. of herbicides used	Percentage	Cumulative percentage^
1	17.1	100
2	17.5	82.9
3	16.4	65.4
4	13.4	49.0
5	10.3	35.6
6	8.6	25.3
7	5.8	16.7
8	4.2	10.9
9	2.9	6.7
> 10	3.8	3.8

^Based upon farmers who reported using herbicides.

Table 2 Active ingredients of the herbicides identified from their trade names

Herbicides	Farmers^ (%)
Paraquat	63.6
Diclofop-methyl	46.2
Chlorsulfuron	36.6
Glyphosate	35.7
2,4-D amine	33.0
Dicamba/MCPA/Bromoxynil mixture	30.1
Simazine	29.8
Diuron	22.5
MCPA (2-methyl-4-chlorophenosy acetic acid)	15.9
Dicamba	10.7

^Based upon farmers who reported using herbicides.

Table 3 Application rates for the five most popular herbicides

	Paraquat (l ha^{-1})	Diclofop-methyl (l ha^{-1})	Chlorsulfuron (g ha^{-1})	Glyphosate (l ha^{-1})	2,4-D Amine (l ha^{-1})
Mean	1.01	1.00	16	1.00	0.54
Minimum	0.02	0.01	1	0.03	0.04
Maximum	10.00	8.57	30	20.00	5.00

Table 4 Years of herbicide use

Years	Farmers (%)
>1	6.1
1–5	28.4
6–10	28.2
11–15	11.0
16–20	12.1
21–25	5.5
26–30	5.5
>32	3.2

indicate whether herbicides were used probably did not use any herbicides, thereby increasing the percent of properties not using herbicides to between 5.6% and 11.4%.

Spray contractors were used on 36.8% of properties including 9.6% who used contractors for all their spraying.

The majority of farmers who used herbicides employed more than one type and some used more than 10. Table 1 displays the number of herbicides used by farmers in this study. The cumulative percentages show the proportion of respondents who used at least that number of herbicides.

Eighty-one brands of herbicide were reported in the survey, although the majority fall into the 10 different active ingredient categories as presented in Table 2. Paraquat and dichlofop-methyl based herbicides were the most common herbicides used.

Application rates for the five most active ingredients are presented in Table 3. The maximum rates given suggest that some excessive use of herbicides has occurred, although it must be recognized that rates were self-reported. Generally, farmers reported using the herbicides at or below recommended rate of application.

The majority of farmers had used herbicides for less than 10 years (Table 4) and 6.1% had used herbicides for less than 1 year.

Application practices

The most common methods of application were by boom spray and misting (90.9% and 25.6% respectively of farmers who spray herbicides). Control Droplet Application (CDA) boom sprays were used by 1.8% of farmers.

A variety of types of vehicles were used for herbicide application. Approximately 30% of farmers used four-wheel drive vehicles for spraying and the remainder used tractors to tow spray booms. The use of four-wheel drive vehicles for spraying is of recent origin with spraying being undertaken at faster ground speeds. These vehicles often have the booms on board. Almost a quarter (24%) of farmers used a vehicle with an air-conditioned or air-filtered cab.

The method of pouring and mixing herbicide concentrates is dependent on the type of filling system used. The traditionally designed top-filling tank was used by 60% of farmers and required pouring and mixing of concentrates by hand. Closed bottom-filling tanks were used by 28.8% of farmers, whereby concentrates are added to the tanks by siphon or venturi methods. The remaining 11.2% of farmers used a mixture of both filling systems.

With the exception of gloves, protective gear was generally not used by farmers (Table 5). Gloves, apron, face shield and eye protection, when used, were generally worn while mixing only, not while applying. Overalls, boots and respirator when they were used, were usually worn while both mixing and applying herbicides. Often overalls and boots were not changed as they were the farmers' normal work apparel thereby increasing the potential for exposure to herbicides.

Insecticide and other pesticides

The use of insecticides, fumigants, dips, drenches and other pesticides by farmers suggests that the majority of the farmers using insecticides used only one type of insecticide. The chlorinated pesticides made up nearly 80% of those used, DDT being the most popular with 38% of farmers using it. This will change dramatically because DDT was deregistered for use in Western Australia in late July 1987.

Of the fumigants and seed dressings used, phosphine-yielding chemicals were used by over 80% of the respondents as a fumigant and lindane-based seed dressings were the most popular of the other agricultural pesticides used. Insecticides were also used as dips, powders, pour-ons, sprays and jettings by 81.6% of farmers. The most popular types included deltamethrin, cypermethrin, cyromazine, fenthion and diazinon as the main active ingredient.

Discussion

The study is a prospective epidemiological investigation into the health effects of agricultural pesticides. The strength of the design is that the health of cereal farmers who use herbicides is being compared to that of cereal farmers who do not use herbicides. Previous studies have compared agricultural workers to the general population, although different occupational, social and environmental factors may influence the health of agricultural workers compared to the population as a whole and thus confound any comparison of the two groups.

The data presented in this paper provide a basis for categorizing participants into exposure groups. They were collected prior to the commencement of the 5-year investigation into the health of the farmers, thereby reducing future recall bias.

DDT had restricted usage at the time of this survey, although it was the most common insecticide used (38% of respondents used DDT on a limited basis). Since the survey, DDT has been more heavily restricted and replaced by other pesticides.

The method of pouring and mixing herbicide concentrates has a large influence on exposure. Farmers who pour concentrates by hand (60% of respondents) are more likely to be exposed during mixing than farmers using closed systems (28.8% of respondents). From a health and safety viewpoint, the closed, bottom-fill, system is preferred, as it reduces the potential for chemical exposure during mixing.

Farmers need further education, and exhortation, about the safe handling of modern agricultural chemical aids.

Acknowledgment

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Table 5 Use of protective equipment during mixing and applying herbicides

Protective equipment	Mixing only (%)	Applying only (%)	Mixing & applying (%)	Total (%)
Gloves	53.5	6.4	18.3	78.2
Apron	8.6	0.8	1.5	10.9
Overalls	7.7	4.1	23.6	35.4
Face Shield	15.3	2.3	3.1	20.7
Eye Protection	5.7	1.4	3.5	10.6
Boots	8.3	3.5	21.9	33.7
Respirator	13.4	8.1	19.6	41.1

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