UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

OFFICE OF
PREVENTION, PESTICIDES AND
TOXIC SUBSTANCES

MEMORANDUM

SUBJECT: Review of Paraquat Acute Illness Data

TO: Christina Manville, Biologist
Occupational and Residential Exposure Branch

FROM: Jerome Blondell, Ph.D., Health Statistician
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Jerome Blondell 10/17/95

THRU: Larry Dorsey, Chief
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Please find below, the OREB review of:

DP Barcode: not applicable

Pesticide Chemical Code: 061601, 061603

EPA Reg. No.: various

EPA MRID No.: not applicable

I. INTRODUCTION

Paraquat is among the more toxic herbicides available for agricultural use (Morgan 1989, Stevens and Sumner 1991). For many years it has been a significant cause of death due to accidental and intentional ingestion. The manufacturer has introduced an emetic agent starting in 1987 as a condition of registration to discourage its use by suicide victims and to help prevent accidental ingestions. Though it is much more difficult to be seriously poisoned by the dermal route or from inhalation, such incidents have occurred. A key problem with paraquat is the lack of any type of antidotal treatment once a person has been over-exposed.

II. CONCLUSION

The following paragraph is recommended for inclusion in the RED:

Paraquat appears to cause fewer poisonings per application than do many insecticides. Most of the fatal cases due to paraquat are related to suicidal ingestions or accidental ingestions. Perhaps 5-10% of all pesticide-related accidental deaths were due to paraquat ingestions in the 1980s. The introduction of an emetic, starting in 1987, is likely to reduce the incidence of death due to ingestion. Probiting concentrates to no more than 5-10% would help prevent deaths that occur from a single swallow. Dermal exposure to paraquat usually results in minor skin or eye irritation, but occasionally can result in more serious effects such as blistered or ulcerated skin, loss of fingernails, skin burns, ulcers of the mouth, nosebleeds, and protracted or even permanent blindness. These more serious effects typically result when protective clothing is not worn, skin has abrasions or open cuts, and/or when extensive exposure is allowed to persist without washing. The label should warn against these hazards. Heavy dermal exposure, as from a leaking knapsack type of sprayer, can result in severe poisoning and even death. About 7 such fatalities have been reported in the literature or by Poison Control Centers. Based on problems with spray drift the California Health Department has recommended that paraquat not be sprayed near residential areas. Such a statement is recommended for the paraquat label.

III. DETAILED CONSIDERATIONS

California data

The California Department of Pesticide Regulation has provided a report of all paraquat cases reported since 1982 to their Pesticide Illness Surveillance System. Physicians are required, by statute, to report to their local health officer all occurrences of illness suspected of being related to exposure to pesticides. The majority of the incidents involve workers. Information on exposure (worker activity), type of illness (systemic, eye, skin, eye/skin, and respiratory), likelihood of a causal relationship, number of days off work and in hospital are provided.

California reported 33 cases of systemic occupational illness from 1982 through 1992 related to paraquat exposure and 26 cases of eye effects, 22 cases of skin effects and 4 combination eye/skin illnesses (California Department of Pesticide Regulation 1995). Five additional non-occupational cases of systemic poisoning were reported during this same time period and 3 of the 5 were fatal suicide ingestions. No accidental deaths were reported, though one case occurred when an application hose disconnected and required 17 days of hospitalization. Table 1 below gives the total number of cases per year in California for all agriculturally-related cases where a definite, probable, or possible causal relationship between exposure and illness were determined.

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Ground application or other direct handling activities were associated with the overwhelming majority (76%) of systemic poisoning. There were 8 cases that related to exposure to drift (2 involving flaggers) and no cases related to field reentry. A variety of crops were reported associated with the 85 paraquat agricultural illnesses. Of the 49 cases where a crop was identified, 11 were associated with grapes, 10 with fruit (3 citrus and 7 other fruit), 9 with weeds, 7 with almonds, 5 with cotton, and 7 with other crops.

Table 1. Number of Agricultural Illnesses reported in California, 1982-1992.

YEAR	SYSTEMIC	EYE	SKIN	EYE/SKIN	TOTAL
1982	5	6	2	1	14
1983	3	6	2	0	11
1984	3	4	4	1	12
1985	3	2	3	1	9
1986	1	1	1	0	3
1987	6	1	3	0	10
1988	1	3	0	0	4
1989	6	0	0	1	7
1990	2	2	4	0	8
1991	3	1	1	0	5
1992	0	0	2	0	2
TOTAL	33	26	22	4	85

The ratio of systemic poisonings (1982-89) for agricultural workers per 1,000 applications was 0.17 (California Department of Food and Agriculture 1983-89). For just workers handling paraquat the ratio was 0.13 per 1,000 applications. This ratio is not high when compared to the median reported for 29 insecticides (.41 for all agricultural workers and .21 for handlers), but may be high when compared to other herbicides. It should be noted that there appears to be a downward trend in California agricultural illness with an average of 10 per year from 1982 through 1987 and an average of 5 per year from 1988 through 1992.

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National hospital data

Earlier data on hospitalized pesticide poisoning permit comparisons with national usage data. An estimated 4.167 occupational cases were hospitalized each year from 1977 through 1982 (Keefe, Savage, and Wheeler 1990). This estimate is based on 3 observed cases in a 6% sample of the nations hospitals. Compared to an estimated 2.84 million pounds in use in 1982, this gives a ratio of 1.5 cases per million pounds in use (Gianessi 1986). This was slightly higher than the average of 1.2 per million pounds, the average for all pesticides. The only herbicide responsible for more occupational hospitalization than paraquat was 2,4-D with an estimated 25 cases per year, but a much lower ratio of 0.6 hospitalized cases per million pounds reported in use.

National Poison Control Center data

Starting in 1989 the American Association of Poison Control Centers reported separately on number of paraquat associated exposures (Litovitz et al. 1990, 1991, 1992, 1993, 1994). A total of 615 reports were received during the five-year period 1989-93. Most of these cases, 84%, were adults and 93% were deemed accidental exposures (7% were intentional suicides or homicides). A total of 73% of all cases were seen at a health care facility. In 55% of the 615 cases a medical outcome was determined. Twenty-nine percent of cases had exposure with no symptoms, 52% had minor symptoms which would not usually require significant medical treatment, 12% had moderate outcome, and 3.6% (12 cases) had major medical outcome indicating life-threatening effects or permanent disability.

There were 9 deaths including 5 that were suicides, 3 accidental, and 1 unknown. Two of the accidental deaths likely involved ingestion and one case involved only dermal or inhalation exposure. From 1985 through 1988 when Poison Centers also reported individual deaths there were 7 deaths reported including 5 suicides and 2 accidental ingestions. According to Morgan (1989) any adult receiving more than about 1-2 swallows of 20% paraquat concentrate (7.5-15 ml) is likely to have a fatal prognosis. On this basis one author has recommended that concentrates of 20% or more should not be sold (Tinoco et al. 1993). On average there were only 3 accidental deaths reported due to herbicides each year from 1980 through 1989 (National Center for Health Statistics 1983-1993). Another 3.3 deaths per year was reported due to unknown type of pesticide. Given 0.62 paraquat deaths per year from Poison Control Centers, it appears likely that paraquat accounts for between 0.6 and 3-6 accidental deaths per year or perhaps 5-15% of all accidental pesticide-related deaths annually. Given this number and percentage every reasonable precaution to prevent accidental ingestion would be justified.

Table 2. Human Paraquat Exposures Reported to Poison Control Centers, 1989-1993.

YEAR	MEDICAL OUTCOME*					TOTAL EXPOSED
	NONE	MINOR	MODERATE	MAJOR	DEATH	
1989	24	36	7	2	1	134
1990	19	47	11	2	3	129
1991	27	38	5	3	4	134
1992	19	35	6	0	1	114
1993	9	21	13	5	0	104
TOTAL	98	177	42	12	9	615

* Medical outcome was determined in about 55% of the total cases that were exposed, which is why the rows do not add up to the total number exposed given in the right-hand column. Five of the deaths are known to be suicides. The number of attempted suicides in other categories of medical outcome is not known, but does not exceed 40 cases over the these four categories.

Incident Data System

The Office of Pesticide Programs has maintained a computer database of all incidents reported to EPA since June 1992. Reports come from various sources including registrants, other federal and state agencies, and environmental groups and individuals. Approximately 20 paraquat incidents have been reported to date. Only 10 of these involve humans and 7 of the 10 were suicide ingestions (6 of which were fatal). None of the 3 accidental human exposures was well enough documented to provide evidence that paraquat was responsible for the adverse effects reported.

Review of pertinent literature

Two articles have been published which review evidence of paraquat poisoning due to dermal exposures (Smith 1988, Garnier et al. 1994). A total of 16 cases are reported including 13 cases which were fatal. In all of these cases the evidence linking the exposure to the adverse effects was deemed convincing. Six of the 13 deaths involved deliberate application to the skin. Another five cases involved prolonged contact with dilute (3 cases) or high concentration (28g/l or 40g/l in 2 cases) paraquat applied from a knapsack type sprayer. Two cases reported contact with dilute spray and previous skin damage from dermatitis or scratches from branches. This evidence plus the single case accidental

dermal/inhalation exposure reported by the Poison Control Centers (above) provide convincing evidence that excessive, prolonged exposure or excessive exposure involving damaged skin can be fatal. Therefore, protective clothing is necessary for handlers of this product whether it be concentrate or dilute.

According to Stevens and Sumner (1991) there are a number of reports of severe skin and eye injury resulting from dermal exposures. Although most exposures result in only mild irritant effects, severe effects to the skin and eyes have been reported when treatment has been delayed (e.g., first degree burns, loss of nails, scarring, blindness). A recent study by Ames et al. (1993) reported on a community exposed to paraquat spray drift. The study reported elevated symptom incidence rates for cough, diarrhea, eye irritation, headache, nausea, rhinitis, throat irritation, trouble breathing, unusual tiredness, and wheezing. Elevated rates of fever and nausea were reported based on an internal comparison among those who reported odors after application. The authors felt the results provided some evidence of paraquat-related symptoms. The authors concluded "This incident reinforces the necessity for proper aerial application, including maintaining proper aircraft height and observing wind velocity restrictions. However, mitigation of paraquat drift exposures may best be accomplished by not spraying near residential communities."

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cc: Paraquat file
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