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Health and Safety Guide No. 51

PARAQUAT
HEALTH AND SAFETY GUIDE

UNITED NATIONS
ENVIRONMENT PROGRAMME

INTERNATIONAL
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WORLD HEALTH ORGANIZATION, GENEVA 1991

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PARAQUAT
HEALTH AND SAFETY GUIDE

This is a companion volume to
Environmental Health Criteria 39: Paraquat and Diquat

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INTRODUCTION

The Environmental Health Criteria (EHC) documents produced by the International Programme on Chemical Safety include an assessment of the effects on the environment and on human health of exposure to a chemical or combination of chemicals, or physical or biological agents. They also provide guidelines for setting exposure limits.

The purpose of a Health and Safety Guide is to facilitate the application of these guidelines in national chemical safety programmes. The first three sections of a Health and Safety Guide highlight the relevant technical information in the corresponding EHC. Section 4 includes advice on preventive and protective measures and emergency action; health workers should be thoroughly familiar with the medical information to ensure that they can act efficiently in an emergency. Within the Guide is a Summary of Chemical Safety Information which should be readily available, and should be clearly explained, to all who could come into contact with the chemical. The section on regulatory information has been extracted from the legal file of the International Register of Potentially Toxic Chemicals (IRPTC) and from other United Nations sources.

The target readership includes occupational health services, those in ministries, governmental agencies, industry, and trade unions who are involved in the safe use of chemicals and the avoidance of environmental health hazards, and those wanting more information on this topic. An attempt has been made to use only terms that will be familiar to the intended user. However, sections 1 and 2 inevitably contain some technical terms. A bibliography has been included for readers who require further background information.

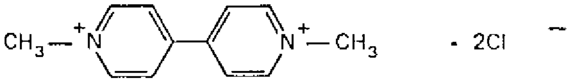
Revision of the information in this Guide will take place in due course, and the eventual aim is to use standardized terminology. Comments on any difficulties encountered in using the Guide would be very helpful and should be addressed to:

The Manager
International Programme on Chemical Safety
Division of Environmental Health
World Health Organization
1211 Geneva 27
Switzerland

THE INFORMATION IN THIS GUIDE
SHOULD BE CONSIDERED AS A
STARTING POINT TO A COMPREHENSIVE
HEALTH AND SAFETY PROGRAMME

1. PRODUCT IDENTITY AND USES

1.1 Identity

Common name	paraquat
Molecular formula:	$C_{12}H_{14}N_2Cl_2$ 1,1′-dimethyl-4,4′-bipyridyliumdichloride (paraquat dichloride) $C_{12}H_{14}N_2(CH_3SO_4)_2$ 1,1′-dimethyl-4,4′-bipyridylium dimethylsulfate (paraquat dimethylsulfate)
Chemical structure of 1,1′-dimethyl-4,4′-bipyridylium-dichloride:	
CAS chemical name:	1,1′-dimethyl-4,4′-bipyridinium (9 Cl)
Trade names:	Gramoxone; Dextrone X; Esgram; and others
CAS registry number:	4685-14-7 (ion) 1910-42-5 (dichloride) 4032-26-2 (diiodide) 2074-50-2 (dimethylsulfate)
RTECS registry number:	DW1960000 (ion) DW2275000 (dichloride) DW2280000 (diiodide) DW2010000 (dimethylsulfate)
Relative molecular mass:	186.2 (ion)

1.2 Physical and Chemical Properties

Pure paraquat salts are white and the technical products, yellow. They are crystalline, odourless, hygroscopic powders.

Some of the physical properties of paraquat dichloride, the salt most used for herbicide formulations, are listed in the Summary of Chemical Safety Information (section 6).

Paraquat is slightly soluble in alcohol and practically insoluble in organic solvents.

Paraquat is non-explosive and non-flammable in aqueous formulations. It is corrosive to metals and incompatible with alkylarylsulfonate wetting agents. It is stable in acid or neutral solutions, but is readily hydrolysed by alkali.

1.3 Analytical Methods

Product analysis and determination of residues can be carried out colorimetrically after reduction; impurities can be determined by gas-liquid chromatography (GLC).

1.4 Uses

Paraquat is a total contact herbicide, applied around trees in orchards and between crop rows, to control broad-leaved and grassy weeds. It kills all green tissues, but does not harm mature bark. Paraquat is used for plantation crops (banana, cocoa-palm, coffee, oil-palm, rubber, etc.) and for citrus fruits, apples, plums, vines, and tea. On certain crops (potato, pineapple, sugar-cane, sunflower), it is used as a desiccant; it is also used as a cotton defoliant.

Uncropped land on industrial sites, railways, roadsides, etc. can be cleared of weeds by applying high concentrations of paraquat.

2. SUMMARY AND EVALUATION

2.1 Environmental Distribution and Transformation

Photochemical degradation takes place when paraquat-treated plants are exposed to normal daylight and continues after the plants die. The products formed have been identified and found to be of a lower order of toxicity than the parent compounds. Ultraviolet degradation on soil surfaces also occurs, but photodecomposition of paraquat in the soil is insignificant in comparison with adsorption on clay particles. Microorganisms can degrade free paraquat rapidly, but chemical degradation of adsorbed paraquat is relatively slow.

(*a*) *Soil*

Paraquat is rapidly and tightly bound to clay materials in soils. The adsorbed paraquat is biologically inactive and, in normal agricultural use, no harmful metabolic or breakdown products are to be expected. In multiple spray trials, paraquat residues in soil varied from 22 to 58 mg/kg. Under field conditions, the residual paraquat is slowly redistributed. Long-term field studies have shown degradation rates of 5–10% per annum, which is usually sufficient to prevent saturation of the deactivation capacity of the soil. Thus, no adverse effects are expected on the soil microflora and other soil organisms, or on crop growth, at normal and high rates of application.

Paraquat is similarly strongly bound to humus and other organic material in soils containing little clay. However, in sandy soils with a low organic content, paraquat may be more readily released into soil water and be more bioavailable to organisms. While it is still unlikely to pose any hazard to the organisms in the soil, its bioavailability to higher animals feeding on soil biota may be increased.

(*b*) *Water*

When paraquat was applied as an aquatic herbicide, at a normal application rate of 1 mg/litre, the concentration was found to decrease to about one half of the initial level within 36 h and to below 0.01 mg/litre in less than 2 weeks. Phytotoxic damage to crops irrigated with treated water is unlikely to occur, if an interval of 10 days is observed between treatment of the water and its use, because of the rapid decrease of paraquat residues in the water.

Normal application of paraquat for aquatic weed control is not harmful for aquatic organisms. However, care should be taken in the application of paraquat to water containing heavy weed growth, since oxygen consumed by subsequent weed decay may decrease oxygen levels in the water to an extent that is dangerous for fish or other aquatic organisms.

(*c*) *Air*

Paraquat is not volatile; thus, inhalation of paraquat vapour is not a problem. The amount of respirable airborne paraquat was found to be negligible under normal conditions of use.

The amount of paraquat present in airborne dust was found to range from 0.0004 to 0.001 mg/m^3. The paraquat was so strongly bound to the dust particles that it did not exert any toxicological effect on rats that were exposed via inhalation.

2.2 Kinetics and Metabolism

Although toxic amounts of paraquat may be absorbed after oral ingestion, the greater part of ingested paraquat is eliminated unchanged in the faeces. Paraquat is poorly absorbed through normal human skin, but the extent of absorption may increase significantly in cases of severe skin damage. The toxic effects of paraquat are largely the result of a metabolically catalysed, single-electron, reduction-oxidation reaction, resulting in depletion of cellular NADPH and the generation of potentially toxic forms of oxygen, such as the superoxide radical.

Absorbed paraquat is distributed via the bloodstream to practically all organs and tissues of the body, but storage is not prolonged in any tissue. The lung selectively accumulates paraquat from the plasma by an energy-dependent process. Consequently, this organ contains higher concentrations than other tissues. Since the removal of absorbed paraquat occurs mainly via the kidneys, an early onset of renal failure following uptake of toxic doses will have a marked effect on paraquat elimination and distribution, and on its accumulation in the lungs.

2.3 Effects on Experimental Animals

Paraquat induces a characteristic dose-related lung injury in the rat, mouse, dog, and monkey, but not in the rabbit, guinea-pig, or hamster. Pulmonary toxicity is characterized by the initial development of pulmonary oedema and damage to the alveolar epithelium, which may progress to fibrosis. Exposure to high doses of paraquat may also cause less severe toxic effects in other organs, primarily the liver and kidney. Minor toxic effects have been noted in the nervous, cardiovascular, blood, adrenal, and male reproductive systems, but only at high doses. Toxic effects have not been reported at low doses of paraquat.

Paraquat has not been found to be teratogenic or carcinogenic in long-term studies on rats and mice. The results of *in vitro* mutagenicity studies were inconclusive, but generally suggested a weak potential activity; the results of *in vivo* studies were negative.

Concentrated solutions of paraquat have been found to irritate both the skin and the eyes.

The FAO/WHO (1986) determined no-observed-effect levels of paraquat dichloride of: 17 and 52 mg/kg diet, equivalent to 1.9 and 5.9 mg/kg body weight, per day, for male and female mice, respectively; 30 mg/kg diet, equivalent to 1.1 and 1.2 mg/kg body weight, per day, for male and female rats, respectively; and 20 mg/kg diet, equivalent to 0.62 and 0.66 mg/kg body weight, per day, for male and female dogs, respectively.

2.4 Effects on Human Beings

2.4.1 *Occupational exposure*

There are several studies on paraquat exposure during normal agricultural use. The main route of occupational exposure of agricultural workers is via the skin. The spray aerosol and dust particles are relatively large and are mostly deposited in the upper respiratory tract. Paraquat aerosol concentrations (total airborne) ranged up to 0.55 mg/m^3 in the work situation, depending on the method of spraying. Under normal conditions of use, the amount of respirable airborne paraquat was found to be insignificant.

The potential dermal exposure of field workers is closely related to working conditions. Workers on tractors were found to have a paraquat exposure of 12–168 mg/h, while spraying between tomatoes or citrus. In other studies, field workers were dermally exposed to paraquat at approximately 0.40 mg/h, and individuals spraying the garden, to 0.29 mg/h. In all trials, respiratory exposure was not higher than 0.01 mg/h. Urine concentrations in occupationally-exposed workers were often lower than 0.01 mg/litre, but concentrations of up to 0.73 mg/litre were determined, after improper paraquat application in tropical agriculture use.

2.4.2 *Poisoning by paraquat*

A large number of cases of poisoning have been reported, following the drinking of concentrated paraquat, overwhelmingly with suicidal intent. A few unusual cases, in which the liquid concentrate was used improperly to treat body lice, have also been reported.

The possibility of patient recovery clearly depends on the dose of paraquat taken and the time interval between ingestion and the commencement of emergency treatment. Speed is imperative, and it should be noted that emergency treatment can start before the patient arrives at hospital.

In less severe cases, without lung damage, recovery has always been complete.

(*a*) *Suicidal ingestion*

The majority of paraquat poisonings are due to swallowing liquid concentrates. The response to treatment is disappointing and the mortality rate is high. Ingestion of granular paraquat is less common and usually causes milder poisoning, though fatalities have occurred.

(*b*) *Accidental poisoning*

Poisoning by accidental swallowing is less common than intentional swallowing and is usually the result of storing liquid concentrates in inappropriate containers, particularly beer or soft drink bottles. The mortality rate is lower than in suicidal cases. Childhood poisoning is usually accidental. In some countries, legislation on the control of the sale of liquid concentrates has reduced accidental ingestion.

A small number of fatal cases of accidental paraquat poisoning via the skin have been reported following the intentional application of liquid concentrates (200 g/litre) to kill body lice.

(c) *Occupational poisoning*

A number of cases of severe poisoning following inappropriate behaviour have occurred. Fatal poisoning through dermal soaking with insufficiently diluted paraquat, associated with severe skin lesions, has been reported. This may result from continuous contact with paraquat-soaked clothing, e.g., as a result of using a leaking sprayer.

Splashes of liquid concentrate may lead to severe ocular and skin damage. Spraying with inadequately diluted paraquat (e.g., with ultra-low-volume application) may result in similar problems.

Local skin effects (contact, irritative, or photoallergic dermatitis), delayed wound healing, and nail damage have been observed among formulation workers and among individuals handling the herbicide improperly. Blepharitis and epistaxis may result through the delayed irritative action of paraquat. Such incidents illustrate the need for strict personal hygiene and rigorous adherence to safe handling procedures (see section 4).

2.5 Effects on the Environment

The fact that paraquat is used as a herbicide indicates that it is toxic for aquatic and terrestrial vegetation.

On reaching the soil, paraquat becomes rapidly and strongly adsorbed on the clay minerals present. This process inactivates the herbicidal activity of the compound. Strongly-bound paraquat does not have any adverse effects on soil microfauna or soil microbial processes.

Paraquat residues disappear rapidly from water by adsorption on aquatic weeds and by strong adsorption on the bottom mud. The toxicity of paraquat for fish is low, and the compound is not cumulative. Normal applications of paraquat for aquatic weed control are not harmful for aquatic organisms. However, when applying paraquat to water containing heavy weed growth, care should be taken to treat only a part of the growth, since oxygen consumption by subsequent weed decay may result in a reduction in dissolved oxygen levels to an extent that may be dangerous for fish.

Treated water should not be used for overhead irrigation for 10 days following treatment.

Normal use of paraquat has been shown not to have any harmful effects on birds.

Paraquat is not subject to bioconcentration and has not been found to accumulate in food chains.

3. CONCLUSIONS AND RECOMMENDATIONS

3.1 Conclusions

3.1.1 *General population exposure*

Residue levels of paraquat in food and drinking-water, resulting from its normal use, are unlikely to pose a health hazard for the general population.

This likely lack of hazard with normal usage of dilute paraquat contrasts strongly with the potentially serious hazard that may result from handling concentrated paraquat.

Accidental paraquat poisoning usually results from swallowing liquid concentrate that has been decanted into unlabelled bottles or other containers, and stored inappropriately.

The number of suicides by means of paraquat is of great concern, but the total number of such suicides is unknown. The reasons for suicide may be manifold and complex, and paraquat is only one among many means towards this goal. However, because of the prolonged and painful way of dying from paraquat poisoning, every effort should be made to diminish its attractiveness and availability for this purpose.

3.2.1 *Occupational exposure*

With reasonable work practices, including safety precautions, hygiene measures, and proper supervision, occupational exposure during the manufacture, formulation, and application of paraquat will not cause a hazard. However, the undiluted concentrate must be handled with great care, because improper work practices may result in the contamination of the eyes and skin (with possible consequent dermal absorption).

Spray concentrations should not exceed 5 g paraquat ion/litre, in order to avoid skin damage and absorption of the herbicide through the skin. Hand-held, ultra-low-volume application should be discouraged.

3.1.3 *Environment*

Paraquat in soil binds rapidly and strongly to clay particles, and residual phytotoxicity from freely-available paraquat is unlikely. The toxicity of paraquat for birds has been shown to be of little significance. Under normal conditions of use, paraquat toxicity for aquatic animal life is low, though the resulting depletion of water-oxygen, because of weed decay, may pose a problem. Paraquat does not seem to present an environmental hazard.

3.2 Recommendations

3.2.1 *General*

Where practical and reasonable, the availability and use of the 20% liquid product should be limited to *bona fide* agriculturalists, horticulturalists, and professional users, who work with trained personnel, properly maintained equipment, and adequate supervision.

Every effort should be made to prevent the practice of decanting into, or rebottling of the product in, improperly labelled containers.

Further research should be carried out, to achieve a safer commercial product and a reduced incidence of fatalities.

National Registers of cases of poisoning should be maintained for all classes of chemicals, including paraquat. The information obtained should be made available to international bodies, such as the World Health Organization.

3.2.2 *Prevention and treatment*

Attention should be drawn to the fact that persons with skin lesions (either pre-existing or following contamination with paraquat) should not be permitted to take any part in spraying procedures, until the skin condition has resolved.

It must be stressed that treatment of persons with paraquat poisoning should be instituted as early as possible. The likelihood of recovery from a potentially fatal dose is greatest when therapy begins within 5-6 h of poisoning.

4. HUMAN HEALTH HAZARDS, PREVENTION AND PROTECTION, EMERGENCY ACTION

4.1 Main Human Health Hazards, Prevention and Protection, First Aid

Paraquat is highly toxic and often fatal, if swallowed. Contact with liquid products can cause severe damage to the skin or eyes. Utmost care must be taken to avoid exposure during handling operations and application in the field. In applications where inhalation exposure to aerosols containing paraquat is likely, proper respiratory protective equipment should be used.

The human health hazards, together with preventive and protective measures and first-aid recommendations, are listed in the Summary of Chemical Safety Information (section 6).

4.1.1 *Advice to physicians*

The most important measures are the *immediate* neutralization of ingested paraquat by 15% Fuller's earth, bentonite, or activated charcoal, and urgent removal of the poison by vomiting or, when possible, gastric lavage. The *urgency* of these measures is such that, where transfer to hospital may involve a delay of an hour or more, the emergency treatment may need to be given by a paramedical person, e.g., a nurse or a medical assistant, *without any delay*. Furthermore, Fuller's earth should be given together with a strong purgative, such as magnesium sulfate or mannitol.

Admission to a hospital (preferably a specialized intensive care unit), either directly, or after emergency treatment elsewhere, is essential.

Where a person has swallowed a lethal dose, **the most important single determinant of survival is the early commencement of treatment.**

Depending on local facilities, patients who reach hospital after the initial treatment will have further treatment aimed at neutralizing paraquat in the gastrointestinal tract (Fuller's earth, bentonite, activated charcoal) or its excretion in the faeces (purgatives, 10% mannitol, gut lavage). In addition, attempts to remove absorbed paraquat from the circulation (haemoperfusion, haemodialysis) or aid its excretion by the kidney (forced diuresis) can be instituted.

Care must be exercised in the administration of most of these treatments, as the following serious complications may occur: perforation of the oesophagus during gastric intubation; serious blood chemistry disturbance, when severe diarrhoea is induced; fluid overload during forced diuresis.

In centres where facilities for analytical procedures are available, measurement of urinary, or, ideally, plasma levels of paraquat may give guidelines for the required intensity of treatment or likely prognosis. Determination of paraquat levels in stomach washings, serum, and urine is useful for the management of poisoning. The urinary levels decline rapidly during the 24 h following exposure and may remain low for some weeks.

Many other therapies including corticosteroids, immunosuppressive treatment, vitamins, β-blocking and alkylating agents, α-tocopherol, superoxide dismutase and/or glutathione peroxides proved to be of no significant importance in human paraquat poisoning. The administration of oxygen should be avoided, unless vital for the patient's comfort.

It should be noted that, as with the great majority of chemicals, there is no specific antidote.

Despite such an array of both simple and sophisticated measures, the response to therapy in paraquat poisoning is disappointing and the mortality rate remains high.

In cases of skin and eye contamination, irrigation with water (preferably running water) should be commenced urgently and must be continued uninterrupted for at least 15 minutes (timed by the clock). Eye cases should always be taken for medical treatment. In cases of skin contamination by the concentrate, or extensive and/or prolonged contamination by the diluted material (particularly where signs of skin irritation are present), the patient must be assessed at hospital for systemic poisoning.

4.1.2 *Health surveillance advice*

Pre-employment and annual medical examinations should be made available to all persons who are regularly exposed to paraquat at potentially hazardous levels. Attention should be given to all normal parameters of overall health status, with particular attention to the state of the skin and of pulmonary function.

4.1.3 *Personal protection and hygienic measures*

- Avoid all contact with skin, eyes, nose, and mouth, when handling concentrated paraquat. Wear PCV-, neoprene- or butyl-rubber gloves (preferably gauntlet form), neoprene apron, rubber boots, and face shield.

- Wear a face-shield when handling and applying the diluted formulation.

- Immediately remove heavily contaminated clothing and wash underlying skin.

- Wash clothes before re-use.

- Do not eat, drink, or smoke, when using paraquat.

- Wash splashes from skin or eyes immediately.

- Do not inhale spray.

- Wash hands and exposed skin, before meals and after work.

- Keep away from food, drink, and animal feed.

- Paraquat should not be sprayed with inadequate dilution, e.g., by hand-held, ultra-low-volume application.

- It should not be used by people suffering from dermatitis or by people with wounds, notably on the hands, until these have healed.

4.2 Explosion and Fire Hazards

Paraquat products are generally not flammable. If involved in a fire, control with dry powder or alcohol-resistant foam. Advise the fire service that protective clothing and self-contained breathing apparatus should be worn, to avoid skin contamination and the breathing of toxic fumes. Confine the use of water spray to the cooling of unaffected stock, thus avoiding the accumulation of polluted run-off from the site.

4.3 Storage

Store technical material and formulations away from heat, under lock and key, and out of reach of children, animals, and unauthorized personnel. Store in an area designated for pesticide storage, preferably without drains.

Store away from foodstuffs and animal feed.

4.4 Transport

Ensure that containers are sound and that labels are securely fixed and undamaged before dispatch. Comply with local transport regulations.

Do not load together with foodstuffs or animal feed.

Accident procedures:

Avoid exposure by the use of appropriate protective clothing, gloves, and goggles or masks. Keep spectators away from leaking or spilled product and prevent smoking, and the use of naked flames, in the immediate vicinity.

Extinguish fires with dry powder, carbon dioxide, alcohol-resistant foam, sand, or earth.

Prevent liquid from spreading to other cargo, vegetation, or waterways by containing it with the most readily available barrier material, e.g., earth or sand.

Absorb spilled liquid and cover contaminated areas with earth, lime, sand, or other absorbent material; sweep up and place in a secure container for subsequent safe disposal.

4.5 Spillage and Disposal

4.5.1 *Spillage*

Avoid exposure by the use of appropriate protective clothing and face-shield.

Empty any product remaining in damaged or leaking containers into a clean empty drum and label.

Absorb spillage with lime, damp sawdust, sand, or earth and dispose of safely (see below). If spillage is large, contain it by building a barrier of earth or sandbags.

Decontaminate empty, damaged, or leaking containers with a 10% sodium carbonate solution, added at the rate of at least 1 litre per 20-litre drum. Puncture or crush containers to prevent re-use.

4.5.2 *Disposal*

Waste containing paraquat should be burnt in a proper high temperature incinerator with effluent gas scrubbing.

Where no incinerator is available, contaminated absorbents or surplus products should be decomposed by hydrolysis at pH 12 or above. A 5% sodium hydroxide (caustic soda) solution or saturated (7–10%) sodium carbonate (washing soda) solution can be used. Before disposal of the resultant waste, the material must be analysed to ensure that the active ingredient has been degraded to a safe level.

Paraquat is rapidly inactivated by clay soil. If the above mentioned methods are not possible, it can be buried in an approved landfill.

Never pour untreated waste or surplus products into public sewers or where there is any danger of run-off or seepage into streams, water-courses, open waterways, ditches, fields with drainage systems, or the catchment areas of boreholes, wells, springs, or ponds.

5. HAZARDS FOR THE ENVIRONMENT AND THEIR PREVENTION

Paraquat is highly toxic for aquatic and terrestrial vegetation. Under normal conditions of use, the toxicity of paraquat for aquatic animal life is low, though resulting depletion of water-oxygen, because of weed decay, may pose a problem.

Do not contaminate ponds, waterways, or ditches with the product or used containers.

6. SUMMARY OF CHEMICAL SAFETY INFORMATION

This summary should be easily available to all health workers concerned with, and users of, paraquat. It should be displayed at, or near, entrances to areas where there is potential exposure to paraquat, and on processing equipment and containers. The summary should be translated into the appropriate language(s). All persons potentially exposed to the chemical should also have the instructions in the summary clearly explained.

Space is available for insertion of the National Occupational Exposure Limit, the address and telephone number of the National Poison Control Centre, and for local trade names.

SUMMARY OF CHEMICAL SAFETY INFORMATION

PARAQUAT

($C_{12}H_{14}N_2Cl_2$) 1,1′-dimethyl-4,4′-bipyridylium dichloride (paraquat dichloride)
CAS registry no. 1910-42-5
RTECS registry no. DW2275000

PHYSICAL PROPERTIES

Physical state	crystalline powder
Colour	yellow
Odour	odourless
Relative molecular mass	186.2 (ion)
Specific gravity (20 °C)	1.240-1.260
Melting point (°C)	175-180
Boiling point (°C)	approximately 300 with decomposition
Solubility in water (20 °C)	700 g/litre
pH of liquid formulation	6.5-7.5
Vapour pressure	not measurable

OTHER CHARACTERISTICS

Total contact herbicide, used to control broad-leaved and grassy weeds; corrosive to metals, and incompatible with alkylarylsulfonate wetting agents; stable in acid or neutral solutions, but readily hydrolysed by alkali; slightly soluble in alcohol and practically insoluble in organic solvents

HAZARDS/SYMPTOMS	PREVENTION AND PROTECTION	FIRST AID
SKIN: Irritating to skin, may cause blisters	Proper application technique; proper skin protection, including impervious clothing and gloves	Remove contaminated clothing; wash skin with soap and water; wash clothes before re-use
EYES: Severe irritant	Wear face-shield; goggles	Flush immediately with clean water for at least 15 minutes; seek medical advice and observe for delayed effects
INHALATION: Irritant to respiratory system	Avoid inhalation of fine dust and mist; use proper respiratory protection	Fresh air
INGESTION: Unlikely occupational hazard	Do not eat, drink, or smoke during working hours; wash hands	
Accidental or deliberate ingestion may cause vomiting, abdominal discomfort, and soreness of mouth and throat; signs of liver and kidney damage may appear in 1-3 days; signs of lung damage may gradually develop after a few days; paraquat can kill		Obtain medical attention immediately; transport to hospital urgently; induce vomiting; **do not delay**

SUMMARY OF CHEMICAL SAFETY INFORMATION (*continued*)

SPILLAGE	STORAGE	FIRE AND EXPLOSION
Absorb spillage with lime, damp sawdust, sand, or earth; sweep up, place in closed container, and dispose of safely; avoid contamination of personnel, ponds, and waterways	Store in locked, well-ventilated storeroom, away from foodstuffs and animal feed, children, and unauthorized personnel	Non-flammable and non-explosive
WASTE DISPOSAL		
Burn in high-temperature incinerator with effluent scrubbing; alternatively treat with 5% caustic soda as a hydrolysing agent; comply comply with local regulations	National Occupational Exposure Limit: National Poison Control Centre: Local trade names:	UN No. 2781, 2782, 3015, 3016

7. CURRENT REGULATIONS, GUIDELINES, AND STANDARDS

The information given in this section has been extracted from the International Register of Potentially Toxic Chemicals (IRPTC) legal file. A full reference to the original national document from which the information was extracted can be obtained from IRPTC. When no effective date appears in the IRPTC legal file, the year of the reference from which the data are taken is indicated by (r).

The reader should be aware that regulatory decisions about chemicals, taken in a certain country, can only be fully understood in the framework of the legislation of that country. The regulations and guidelines of all countries are subject to change and should always be verified with appropriate regulatory authorities before application.

7.1 Previous Evaluations by International Bodies

The FAO/WHO Joint Meeting on Pesticide Residues (JMPR) has reviewed residues and toxicity data on paraquat on several occasions (1970, 1972, 1976, 1978, 1981, 1982, 1985, and 1986). In 1986, it estimated the acceptable daily intake (ADI) for man to be 0–0.006 mg paraquat dichloride/kg body weight (or 0.004 mg paraquat ion/kg body weight).

The same JMPR recommended maximum residue levels (tolerances) for paraquat in food commodities of plant and animal origin.

The WHO/FAO (1979), in its series of "Data sheets on chemical pesticides", issued one on paraquat (No. 4). It classified technical paraquat as moderately hazardous in normal use (WHO, 1990).

7.2 Exposure Limit Values

Some exposure limit values are given in the table on pages 30–32.

7.3 Specific Restrictions

Paraquat is prohibited for use in, amongst other countries, Finland and Sweden.

CURRENT REGULATIONS, GUIDELINES, AND STANDARDS

EXPOSURE LIMIT VALUES

Medium	Specification	Country/ organization	Exposure limit description[a]	Value	Effective date
AIR	Work-place	Argentina	Maximum permissible concentration[b]		
			- Time-weighted average (TWA)	0.1 mg/m^3	1979
		Australia	Threshold limit value (TLV)[b]		
			- Time-weighted average (TWA) of respirable dust (provisional)	0.5 mg/m^3	1983
		Belgium	Tolerable limit value (TLV)		
			- Time-weighted average (TWA)	0.1 mg/m^3	1988
		Bulgaria	Maximum permissible concentration[b]		
			- Time-weighted average (TWA)	0.1 mg/m^3	1987
		Germany, Federal Republic of	Maximum work-site concentration (MAK)[b]		
			- Time-weighted average (TWA)	0.1 mg/m^3	1988
			- Short-term exposure level (STEL) (5 min) (8 × per shift) (ceiling value)	0.2 mg/m^3	

		Hungary	Maximum permissible concentration		
			- Time-weighted average (TWA)	0.02 mg/m^3	1978
			- short-term exposure level (STEL) (30 min)	0.02 mg/m^3	
		Netherlands	Maximum permissible concentration		
			- Time-weighted average (TWA)	0.1 mg/m^3	1986
		Switzerland	Maximum work-site concentration (MAK)[b]		
			- Time-weighted average (TWA)	0.1 mg/m^3	1987
		United Kingdom	Recommended limit		
			- 8-h Time-weighted average (TWA) (of respirable dust)	0.1 mg/m^3	1987
		USA (OSHA)	Permissible exposure limit (PEL)[b]		
			- Time-weighted average (TWA) (respirable dust)	0.1 mg/m^3	1989
		USA (ACGIH)	Threshold limit value (TLV)		
			- Time-weighted average (TWA) (respirable sizes)	0.1 mg/m^3	1987
FOOD	Intake from	FAO/WHO	Acceptable daily intake (ADI) (paraquat ion)	0-0.004 mg/kg body weight	1986

CURRENT REGULATIONS, GUIDELINES, AND STANDARDS (*continued*)

EXPOSURE LIMIT VALUES (*continued*)

Medium	Specification	Country/ organization	Exposure limit description[a]	Value	Effective date
FOOD	General	FAO/WHO	Maximum residue limit (MRL) for specified products	0.01-10 mg/kg	1983
		European Community	Maximum levels in and on fruit and vegetables (expressed as paraquat cation)	0.05 mg/kg	1989

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[a] TWA = time-weighted average over one working day (usually 8 h).

[b] Skin absorption.

In some other countries, e.g., the Federal Republic of Germany, Hungary, the United Kingdom, and the USA, the use of paraquat is only registered for certain specified applications or for use under certain specified conditions. For instance, in the United Kingdom and the USA, the use of the 20% liquid is restricted to *bona fide*, certified professionals. In the Federal Republic of Germany, paraquat may not be handled by adolescents or pregnant or nursing women.

7.4 Labelling, Packaging, and Transport

The United Nations Committee of Experts on the Transportation of Dangerous Goods classifies paraquat in:

- Hazard Class 6.1: poisonous substance.
- Packing Group II: substances and preparations presenting a serious risk of poisoning, when the active ingredient is within the range of 40–100%.
- Packing Group III: substance presenting a relatively low risk of poisoning in transport, when the active ingredient is in the range of 8–40%.

The labels should be as follows:

Division 6.1

Poisonous (toxic) substances
Packing Groups: I and II
Symbol (skull and crossbones): black; Background: white

Division 6.1

Poisonous (toxic) substances
Packing Group: III
The bottom half of the label should bear the inscriptions:
HARMFUL
Stow away from foodstuffs
Symbol (St. Andrew's Cross over an ear of wheat): black; Background: white

CURRENT REGULATIONS, GUIDELINES, AND STANDARDS

The European Economic Community legislation requires labelling of paraquat as a dangerous substance using the symbol:

T

Giftig
Giftig
Τοξικό
Toxic
Toxique
Tossico
Vergiftig

The label must read:

> *Toxic in contact with skin and if swallowed; irritating to eyes, respiratory system and skin.*

The European Economic Community legislation on the labelling of pesticide preparations classifies paraquat in Class 1A, for the purpose of determining the label for preparations containing paraquat and other active ingredients.

The chemical name must be stated on the label.

The FAO specifications for plant protection products containing paraquat specify the composition and purity of its formulations and the methods for checking this. They also specify the quality of the containers.

7.5 Waste Disposal

In the USA, paraquat is regarded as a hazardous waste and permits are required for its discharge from any point source into USA national waters. This requirement contains detailed instructions.

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