**Introduction**

"Paraquat is the B.S.I. (British Standards Institution) common name of the cation 1,1'-dimethyl-4,4'-bipyridylium, which is available as the dichloride of the di(methyl sulphate)."[[1]](#footnote-2) This is the formal description of the herbicide paraquat, which was characterised, tested and formulated by Plant Protection Limited, a subsidiary of Imperial Chemical Industries. The chemical's herbicidal potential was first observed in 1947 and work started in earnest on paraquat from 1955. An agricultural paraquat product, Gramoxone W, became available to farmers and horticulturalists in 1962, followed in 1965 by Weedol for amateur gardeners. This chapter looks at the development of paraquat as a herbicide, its reception in Britain, and how some users were determined to ignore the use categories set by the product makers.

**Development of paraquat**

Paraquat is rapidly inactivated by contact with the soil, which dampened enthusiasm raised by it's unusual herbicidal strength. Recently developed weedkillers on the market such as Fison's simazine were used to suppress weed growth by remaining active in the soil for months. Scientists at Plant Protection had developed MCPA (2-methyl-4-chlorophonoxy acetic acid) which was a 'hormone weedkiller' and from 1946 a part of a new era in chemical weed control, increasing the area that could be treated quickly and effectively. MCPA persisted in the soil, was taken up by the roots and killed broad leaved weeds, termed a 'selective' killer as it left grasses such as wheat crops unaffected. A 1958 market survey indicated that there was a strong demand for similar, even more selective, hormone weedkiller.[[2]](#footnote-3) Had the demands of these unimaginative potential users been blindly prioritised, it would have prevented Plant Protection developing the herbicide. Carrying out market surveys to guide product development can be helpful, but companies are also very effective at creating and promoting new uses that their customers had not considered. Chemist William (Bill) Boon viewed inactivation as a useful property and persuaded his reluctant colleagues that paraquat was worth developing. Using Schon's dissection of successful innovation, Bradbury *et al* identified Boon as the 'product champion'.[[3]](#footnote-4) As champion for the bipyridyl herbicides, previously involved in successful development of manufacturing processes for Mepacrine (an antimalarial drug) and penicillin, eventually appointed head of research at PPL, medal winner and Fellow of the Royal Society, in company histories[[4]](#footnote-5) Boon emerges as the only visible researcher in the stories of paraquat, even in accounts written by members of ICI.[[5]](#footnote-6) This in/visibility is common to most accounts of 20th century scientific discoveries which took place in institutions or corporations,[[6]](#footnote-7) and is something scientific researchers, and business historians, appear to accept. Boon retired from ICI in 1973, and apart from the interview by Kennedy[[7]](#footnote-8) little can be gleaned about his thoughts on paraquat after it left the laboratory bench. This is a shame, because once in the hands of users paraquat gained a reputation as a 'killer chemical'[[8]](#footnote-9) and the tension that resulted from the desire to protect people from harm, yet keep an extremely effective herbicide available for use is the central story of this chapter.

**Company history**

When intense work started on the quaternary salts that would yield paraquat and the closely related diquat **introduce the chemicals more thoroughly earlier**, Plant Protection Limited was jointly owned by ICI, and Cooper McDougal and Robinson but changes would take place before any products reached the market. Cooper McDougal and Robinson had been established in the crop protection business longer than ICI, and in 1937 when ICI started to work in this area, Plant Protection was formed as an attempt to prevent intellectual and sales territories being encroached and allow networks of contacts to be taken advantage of. Chemicals which were synthesised both at ICI's Dyestuffs division and their General Chemicals division, respectively based in Blackley in Lancashire and at Runcorn in Cheshire, were then sent for field testing and development at the Plant Protection facilities, Jealott's Hill and Fernhurst, in Kent. The geographic separation of chemists from the biologists and agriculturalists slowed exchanges and in 1954 a team of five chemists, including William Boon, moved south to be permanently based at Jealott's Hill. Perhaps this contributed to the delay between the discovery of herbicidal action, and the development of commercial products.

In 1959, the year that the first 50lb batch paraquat was made, it was evident that the crop protection business was losing money and became the subject of a restructure. Plant Protection became wholly owned by ICI, who had been taking the largest burden of subsidising the business. Redundancies followed, with most of the cuts at Fernhurst, though Jealott's Hill also felt the effect, resulting in a certain amount of bitterness and disruption.[[9]](#footnote-10)

That commercial paraquat products reached the market as fast as they did in 1962 shows the commitment of those involved to overcome this transitionary and potentially disruptive period, though stemming the drain of money and generating income must have been strong motivators. That first 50lb batch cost £50 000 and for the development of the herbicide to go ahead, a much more economic method had to be found.[[10]](#footnote-11) Bradbury describes Plant Protection as able to call directly on Mond for help to make paraquat, although he doesn't say why they didn't do this for diquat, which although no-one at PPL could formally direct research to be carried out elsewhere, was apparently such a beguiling chemical problems that the project researched at multiple international locations.[[11]](#footnote-12) Paraquat was different as researchers and engineers at one organisation and location, Mond, built a "pioneer plant" in 1961 and crudely produced enough paraquat for field testing. New, more efficient pathways and processes were worked out there for a second plant in1962 and a third generation plant in 1968 (?), with FR Bradbury, CW Suckling and MB Green being mentioned as important in paraquat's commercial development.[[12]](#footnote-13)The financially viable process was also "so complex that it assured a virtual monopoly of manufacture".[[13]](#footnote-14)

This schedule of paraquat production shows that it was very early on in trials that the company started to widely promote paraquat as Gramoxone with promotional stories appearing in agricultural news from August 1962,[[14]](#footnote-15) and that even Weedol was on the market in 1965 before an efficient manufacturing method was fully in their grasp. They must have been very confident that there was enough demand for their products, or that the demand could be generated, to go ahead product with development and to continue investing in improving the manufacturing process.

In paraquat's properties Boon saw the potential for, and with the teams of researchers at Plant Protection developed, not just a herbicide, but completely new systems of arable farming and pasture regeneration. Boon thought a herbicide that left a mulch of dead vegetation on the surface could help retain moisture and protect the soil from wind, both would prevent soil erosion.[[15]](#footnote-16) Soil erosion might not have been of concern to many British farmers, but in export markets such as Russia[[16]](#footnote-17) this attention to benefits could help enhance sales/ choose the product. The potential to avoid or reduce ploughingwas the concept behind ICI's promises that paraquat would revolutionise farming, although the chemical plough idea only started to be fully tested from 1962, the year it became generally available to agriculturalists and horticulturalists. √These new methods of using a weedkiller were not fully articulated or tested when Gramoxone was launched, but this extra layer of value or uses beyond effective weed control was a promise that ICI proclaimed from paraquat's launch.[[17]](#footnote-18) In this way, these early agricultural users were experimental users, as the best methods of using the chemical were worked out in different scenarios. Researchers, engineers and farmers spent the following eight years developing machinery to allow seeds to be planted with minimal ploughing.[[18]](#footnote-19)

Despite hyperbolic stories in the press about farms being deserted thanks to the chemical plough[[19]](#footnote-20), the direct drilling method was slow to be adopted, possibly because of the need for new expensive (and not fully reliable) equipment that could plant seed directly into the ground.[[20]](#footnote-21)

When Plant Protection were trying to get clearance from the Advisory Committee on Poisonous Substances Used in Agriculture and Food Storage in 1962, they presented results from acute and chronic LD50 tests on rats, rabbits and a small sample of hens. Over time these were supplemented with observations from real use scenarios or investigations triggered by real world questions, such as the time vegetation should be left before animals could eat it. Disruption of finger nail growth and nosebleeds in staff packing the chemical had also been observed, explained away by improving the use of gloves and better ventilation. A variety of possible mechanisms were discussed by the scientists on the committee and Plant Protection representatives, but why animals died and why ICI workers had been affected in that way was not known.[[21]](#footnote-22) The benefits of the chemical seemed to outweigh the potential problems, problems that could be avoided if sensible precautions were taken. This vital stage of development is not remarked on by Bradbury or Kennedy, who focused on the organisational structures and individuals within them.

Scientists and technologists (researchers?) at Plant Protection continued work formulating, testing and seeking approval for a less concentrated paraquat-based weedkiller for domestic or amateur gardeners. Paraquat, the active ingredient, was only 5% instead of 20% as it was in Gramoxone. Plant Protection branded it Weedol, a much more descriptive and potentially user friendly name than Gramoxone, and this weaker version was marketed widely from 1965. This descriptive name was confusing similar to Fison's long acting, total weedkiller based on simazine which had been on the market since 1959, Weedex.[[22]](#footnote-23)

In 1963 ICI placed a more general educational advert in main body of the The Times entitled "Research, The Springboard of Progress" about the benefits of selected ICI products: Gramoxone, leprosy treatment and wipeable wallpaper.[[23]](#footnote-24) Educational, profile boosting adverts were a staple feature of ICI's communication with the general public about their work and public relations for the chemical industry in general. ICI's underlying promise was that paraquat would boost the nation's total area of agriculturally productive land thus improving self sufficiency in its food supply, and when exported overseas was set to guarantee riches to the UK's chemical industry. In post-war Britain which was rebuilding its economy and anxious about reliance on imports, this was an encouraging message. Later, as the United Kingdom suffered in a recession in the 1970s, ICI again called on paraquat to demonstrate the company's contributions to every day life, and the British economy. "Ideas in Action from ICI" was placed in the Daily Mail in 1974 which showcased more of their revolutionary products, with Gramoxone being first on the list, followed by "the world's most widely used anaesthetic" and 'BCF' liquified gas to put out fires "saving precious seconds, precious lives."[[24]](#footnote-25) In this advert, which was part of a series, their message was summed up "Changes for the better, world wide". In addition, ICI spelled out how much money the company was making, investing and recirculating through using "35 000 suppliers" in the UK, which seems to be an effort to show the company in a positive light when the country was in recession.

**Testing paraquat, in relation to toxicity and legislation**

In addition to herbicidal efficacy, safety tests had to be carried out before the new herbicide could be marketed.Tests took the form of acute and chronic toxicity tests on rats.

In a report written \*\*for xxx\*\* by Plant Protection about Weedol in 1964, they stated that "there are no particular clinical tests of symptoms applicable to poisoning with this product. In case of gross contamination normal first aid measures should be used."[[25]](#footnote-26) Their cautions to the user on the draft label were "For use only as a garden herbicide. Store in a safe place. Safely dispose of empty container. Keep off skin. Avoid inhaling spray. Harmful to animals. Wash utensils throughly after use. Store safely, away from children."[[26]](#footnote-27) These are very similar to the warnings given to the users of the concentrated form, which included the additional instruction prohibiting repacking into other containers.

No tests of symptoms - symptoms of poisoning were usually provided in tables or list forms in first aid guides and household management manuals. These described what the first aider should look for, such as sleepiness, bottles of household chemical or medicines and help them to choose an appropriate action such as encouraging vomiting, or drinking milk, water, coffee. It is true that paraquat didn't burn, like corrosive fluids, didn't necessarily cause vomiting, so this statement is indeed true. There were clinical tests, such as detecting paraquat in urine or blood, using colorimetric tests, and this method was used to quantify exposure during spraying by agricultural workers, by measuring the absorption and excretion of paraquat. These tests could establish the presence of paraquat in a poisoning victim, so it was not a method of killing that could go undetected but these were not routine tests to do and there were instances where the victim was hospitalised for weeks before this kind of test was run. Pathological tests showed changes in the lungs, which were characteristic of paraquat.

**Discussing Branding**

Paraquat was not available as an unbranded product and ICI considered attempting to obtain an extension to their patent in order to keep their stronghold. Ultimately they did not go through with the challenge because the patent for manufacture was applied for and therefore finished later, giving the company more time. The idea of more companies making paraquat products caused concern which was expressed in Parliament and in newspapers where it was held that ICI who were working on treatments for poisoning should continue to be responsible for the potentially dangerous chemical.

**Changes to the formulation**

When reformulating gramoxone to improve its safety, PPL looked to ICI discoveries, as well as outside the organisation. One of the additions was a triazolopyrazine made by FL Rose and colleagues, then trialled by ICI as a bronchodilator, but rejected because it caused patients to be sick.[[27]](#footnote-28) Detailed records in the organisation meant that when an emetic was required to minimise intestinal absorption of paraquat, there were options in-house. Bitrex

Vale et al described in 1987 that paraquat itself causes nausea vomiting and diarrhoea due to its irritation of the gut. The paper also stated that all recent formulations contain an emetic, PP796, a phosphodiesterase inhibitor to directly stimulate the vomiting centre. Granular preparations (Weedol, Pathclear) contain magnesium sulphate, stimulating diarrhoea.[[28]](#footnote-29) These changes to formulation were made to try to eliminate the chemical from the system of the person who had consumed it \*need to find out when\*.

**Imagined users**

ICI had imagined the user of Gramoxone to be an arable farmer or agricultural worker. Gramoxone was not intended for use by the general public, so it might be expected that adverts for this agricultural product would not to be placed outside specialist publications. The Times carried detailed case study type adverts for Gramoxone in their regular farming supplements in 1963[[29]](#footnote-30) and 1964.[[30]](#footnote-31) This can be interpreted as evidence that Plant Protection and ICI viewed The Times as enabling them to present their products, and associated practices, to farmers or decision makers who were known to be amongst the readers as they would not pay for their advert to be placed somewhere they didn't think it would pay off for them. Perhaps advertising here was even a good investment to publicly show ICI shareholders what they were doing. The adverts for this product show their ideal farmer, someone willing to try new things, taking advantage of fresh agricultural grants, maximising yields and profits. The farmers and farm managers pictured in these adverts are male, although there are letters in the MAFF folders from farmers who were women, admittedly they appear because they are concerned about an aspect of its use.

The development of a completely different paraquat formulation, Weedol, for use at home, at a quarter of the strength of the agricultural product, demonstrates that the company accepted that the chemical was too dangerous to have in a domestic environment. Initially, Weedol was proposed as a liquid mixture of diquat and paraquat, to be sold in 20fl oz glass bottles[[31]](#footnote-32) but the reaction from the Subcommittee meant that the formulation was significantly changed. Domestic users were imagined to be unused to handling agrochemicals, which is probably correct, and therefore at risk from diluting a concentrated liquid,[[32]](#footnote-33) although this is questionable. Domestic users' experience with other household chemicals such as bleach, ammonia or caustic soda does not seem to have been considered, and in this lack of imagination, agrochemicals are defined as different and inherently more dangerous. It is interesting that this distinction is made and made without question.

Diquat also caused concern, as rabbits had developed cataracts after exposure to it, so this component was removed from the early domestic Weedol formulations,[[33]](#footnote-34) yet it remained in agricultural preparations Reglone and Preglone, again demonstrating an imagined difference between the ability of farmers and domestic users to treat the products with appropriate care. In the 1970s, diquat was incorporated into a new improved version of Weedol.

Advertisements for Weedol depict an imagined domestic user, who is a middle aged male, probably in his own garden, where he's using it among flowers and shrubs - not to clear expanses of weeds in an industrialised setting, and he's at leisure - he's wearing a casual jumper, smoking a pipe. The dress and actions of the gardener using Weedol in these adverts communicate how easy and clean using the product is. If Weedol was not available, meaning they had to manually weed instead, they would have to wear clothes that could get grass stains and mud on them, so the pale cable knit jumper, the white shirt cuffs show how mess is avoided. The presence of the pipe is a symbol of leisure, but also of safety. If the user had to weigh out the chemical, they risked getting it on their hands then transferring it to the pipe and from there into their mouths. Dissolving Weedol directly in a watering can avoids this problem. Perhaps these men would have been less used to handling potentially dangerous chemicals, leaving that to their wives. Perhaps the comfort of home, leisurely activities, meant that vigilance and care that men might have applied to handling substances in their working lives was dropped once in the domestic environment.

Standing up to weeds is perhaps not war like, but it is sending dual message - that you don't have to be beaten by weeds and you don't have to be on your knees, you can stand up to weed... Again, it's the man doing this task. Are women less inclined to use weedkillers? Are women supposed to be nurturing rather than killing? Maybe that'll come through in oral history work or more archival research.

We can see from these verbose, very informative if you take the time to read them -adverts that great pains were taken to put across the ease and simplicity of use, using the plants natural processes to kill the plant. There is no mention of the percentage of active ingredient. The product is not related in any way to gramoxone by these adverts, but equally no attempt is made to distinguish it from it. In a way, ICI needed the success of the agricultural chemical to get domestic users to seek out paraquat based products. We can just about see some of the precautions, and restrictions - here is says only use as a garden weedkiller.

**Model Users**

Weekly gardening columnists are what I term “model users” because they lead the way, modelling in their own gardens how to correctly use the chemical and setting the schedule for using the herbicide by suggesting when do use it. The trope of “jobs to do this week” is well used in their articles, where very similar advice on weeding, planting, fertilising might be set out in gardening almanacs or books, the articles add topical comment on rain or sun, or other events to supplement and fine tune the advice. In part, they are also experimental users

Gardening columns were often driven by readers' letters, and in that year readers of the Times wanted to know why Roy Hay kept casually recommending a potentially lethal chemical to them, without ever mentioning risk.[[34]](#footnote-35) The columnist reiterated the existence of a domestic version which was much safer. But to be fair to the readers, he usually simply said paraquat rather than specifying the brand name Weedol, described the domestic version as "smaller packs" rather than less concentrated, and directed them to follow the manufacturers' instructions.

Columnists continued to offer paraquat as an option for home gardeners, even when closer reading of descriptions of their own gardens and practices showed that they chose not to use paraquat in as many situations as they suggested. It became clear that the columnists for the Mail and the Times actually preferred to use cover planting to avoid weeding, limiting the amount of bare soil that could be colonised by weeds. However, for many of their readers, this aesthetic was alien and messy. The culture of digging was still strong, with the columnists exhorting an either or approach, either use weedkiller and do not dig, or dig and do not use weedkiller, as disturbing the soil brought more weed seeds to the surface to germinate. Using Weedol while the weed seedlings were tiny would ensure that the resulting dead material would quickly dissolve away. Weedol required a significant change in gardening practice, targeting seedlings rather than visible, grabable weeds. Using the chemical on larger weeds didn't give such satisfactory results, leaving a desiccated, dead plant which would then have to be pulled out, inevitably disturbing the soil and encouraging new weed growth.

**Communicating about paraquat - safety**

The concept of chemical persistence was raised in public awareness through Rachel Carson's *Silent Spring* published in the United States in 1962. Agrochemicals that remained detectable (never mind active) in the soil, on foods as residue, in water and shown to accumulate in animal food chains over a long period of time were all imbued with the potential for unknown, damaging, long term effects like those of DDT on iconic bird species. An unusually effective chemical that was proved to be quickly, and naturally (that is without the addition of any other manufactured products) rendered harmless in the soil could have been an attractive option for marketing to large scale users and home gardeners alike after the desolate visions that Carson conjured up. However, this specific, and perhaps speculative, environmental aspect was not highlighted in the advertising material, although generic harmlessness was a consistently prominent feature of adverts. Here the focus was on the 'naturalness' of both the herbicidal action and the deactivation of paraquat by the soil. In an article entitled "Chemicals threaten wildlife" paraquat is mentioned as breaking down quickly and is therefore not a threat, whereas other, dissimilar in use chemicals, are persistent and dangerous.[[35]](#footnote-36)

7 million units were sold while Weedol had provisional commercial clearance, which was treated as a time to make observations of the real life use scenarios. It was sold as packets of granules or pellets, where the whole 2 ounce packet was to be dissolved directly in a 2 gallon watering can.\*\*check weight - was it 2 or 1oz?\*\* This meant that the user should not have to measure out or handle the product, as well as there being no left over granules to store, and the whole liquid amount used up. From the product launch in 1965 to May 1967 there were 8 reported medical incidents involving Weedol. Three were attempted suicides, one was a child eating the granules "who should not have access to the preparation" and four arose "during application of the chemical and resulted from carelessness".[[36]](#footnote-37) By "attempted" suicide, we infer that they were not successful, the child was not fatally poisoned and there is no detail on the extent of any of the "careless" weeders injuries.

**Experimental Users**

When Weedol was sent out with Plant Protection staff for testing at home, this single use sachet raised questions about the size of commonly owned watering cans, and thus what could reasonably be expected to give reliable results.[[37]](#footnote-38)

**Disobedient or Careless users**

Gramoxone had a concentration of active ingredient paraquat at 20%. The herbicide arrived with users as a brown liquid and among the warnings about avoiding contact with skin and eyes, there were instructions that as a condition of sale, it should not be repacked from the original containers.

Perhaps inevitably, Gramoxone was repacked into drinks bottles and from 1966 news of accidents started to reach Plant Protection.[[38]](#footnote-39) Plant Protection and regulatory committees were interested in collecting information about all kinds of accidents, whether from skin contact so that sales restrictions and printed warnings could be examined to see how well they worked and if they needed amending.

Crofters and other small scale agricultural users, especially in Ireland, were identified by Plant Protection as a population of users who were particularly prone to buying small amounts of agricultural chemicals in reused containers such as drinks bottles and were accordingly disproportionately accidentally poisoned.[[39]](#footnote-40) The powerful herbicide impressed workers[[40]](#footnote-41) whose job it was to clear unwanted vegetation - agricultural workers, council workers, people maintaining runways and railways - and, disregarding whether they had permission or not, they took it home for themselves or friends to use. MAFF described people who brought home Gramoxone from agricultural or horticultural stocks as trying to avoid the expense of buying Weedol.[[41]](#footnote-42) From the circumstances reported in newspapers, liquid paraquat preparations tended to be brought home by quite young men, who worked in agricultural or horticultural jobs or were in social circles with people who could access the high concentration product. One of the accidents occurred in a static caravan park, not generally known for the wealth of their inhabitants.

The familiar shapes of drinks bottles, an important part of their brand identity, sent out the wrong signals about safe contents when they were reused to store agrochemicals. The bottles of concentrated herbicide found their way into bags, glove compartments, sheds, kitchens and even fridges where they were mistaken for dark coloured drinks: cola, Ribena,[\*\*ref\*\*] stout [\*\*ref\*\*] then swigged by curious or thirsty children, teens and adults, with very serious and sad consequences. When drunk, paraquat could be quickly absorbed into the blood, with pathologists warning that a mouthful could be lethal even if it was spat out,[[42]](#footnote-43) or speculating that a graze on a child's knee could be an entry point for a fatal dose if they played in a recent sprayed field[[43]](#footnote-44) although I did not find any reported cases of this being the route of poisoning.

As well as irritating and ulcerating the mouth and throat, paraquat has a peculiar effect on lung tissue in particular, irritating and thickening the membranes that gas exchange occurs across, reducing the efficiency of the organ, but also causing cell proliferation in the lungs which thicken so much that the lungs solidify, pulmonary fibrosis. Despite doctors' best efforts to deactivate paraquat with Fullers earth, or kaolin mimicking the deactivation seen in soils,[[44]](#footnote-45) or to dilute the chemical in the bloodstream through forced diuresis as was successful in treating barbiturate overdoses,[[45]](#footnote-46) in the early days of gramoxone poisonings it was a horrifyingly certain and slow death, potentially over two weeks or more. In September 1967, an editorial in the BMJ preceded an account of an "unusual" suicide by injection of concentrated paraquat, which took place in Israel and was not reported in mainstream UK newspapers. In this editorial, attention is drawn to the UK case of of a child sent homes who had appeared to have recovered from accidental paraquat poisoning, but died two weeks later. It is interesting to see the medical profession faced with this new chemical, sharing information and trying to learn how to deal with it to best treat the patient as well as protect their profession. Special care is taken to ascertain from the patient what kind of weedkiller it was, implicitly highlighting that doctors need to think beyond what worked for arsenic based weedkillers or other poisons which might not necessarily be appropriate in this situation. Readers are urged to to consider the possibility of renal failure, as well as delayed development of fibrosis with an eye to these apparent early recoveries, which shows that the potential for effects to catch medical staff out who are not up to date with the newest chemicals available. It also puts expert medical technologies, dialysis, at the forefront of this.[[46]](#footnote-47) As more literature accumulated on treating these poisonings, medical staff had a better idea of what they were dealing with and what the relationships were between dose ingested, or absorbed through the skin, and outcome, as there were many who didn't take a fatal dose, especially if they took the granular preparations, and that providing they were rehydrated they wouldn't suffer renal damage. It is telling that in 1987, once the dose has been established as being in the severe bracket the advice is to focus on palliative care and supporting the patient and their family towards the end of life.[[47]](#footnote-48)

A 1967 note about repacking, following "three or four fatal poisonings" in which Roy Goulding wonders how to prevent this. He writes "How we can deter them I don't know, but labelling the concentrate as poison might help. Ordinarily, I realise, we ask the Poisons Board to list and schedule only regulated chemicals. Presumably there is no rigid rule about this. Could we discuss this formally at the next meeting of the Sub-Committee? The irony is that Northern Ireland, having no notification scheme is making a big fuss about this!”

Plant Protection were resistant to suggestions that the word "Poison" should be included on the label, preferring the less hard hitting, alternative wording "Not to be taken" and "Harmful if taken" or "Dangerous if swallowed".[[48]](#footnote-49) They maintained that when users followed the instructions, the product was safe.

**Intermediaries as Users?**

However, it wasn't just the end-users who failed to adhere to the instruction that Gramoxone was not to be repacked, as a case reported in a 1968 Cambridge newspaper told of a store that sold Gramoxone in a reused lemonade bottle, delivering it to the purchasers' doorstep.[[49]](#footnote-50) Luckily no-one was poisoned, but the chemist was found guilty of gross carelessness and fined. In 1967 Plant Protection sent what they called a "strongly worded letter" to its main agents and distributors reminding them about the dangers of selling Gramoxone that was not in its original container.

**Educating/ Disciplining Users**

Journalists remained objective in their reporting of accidental poisoning with Gramoxone, although they didn't mince words when they could be delivered from authority figures. William Boon, father of paraquat, was reported as attributing accidental deaths to "human stupidity". \*\*findref\*\*Keeping Gramoxone in unmarked, reused bottles was "asking for it", The Times reported coroner Donal Summerfield as saying.[[50]](#footnote-51) As poisonings of this type accumulated, a coroner was reported as frustratedly saying "when will the public learn?",[[51]](#footnote-52) but the reporters at the paper did not expand or moralise on the subject of those who chose to use Gramoxone at home.

Despite fatal incidents occurring since 1966, none were reported in newspapers until 1968. Before that date, stories about paraquat were limited to the farming, business or gardening columns, which only proclaimed the benefits of the herbicide. The front page news of Britain's, even Europe's, first lung transplant in 1968 is also one of 15 year old Alex Smith's accidental paraquat poisoning. Although the focus of the stories is of the surgical procedure, most papers mention an unnamed weedkiller. The Times reported “liquid weedkiller” that “resembled a soft drink”.[[52]](#footnote-53) In the series of articles following the transplant, The Mail did not name the weedkiller either, but it is clearly gramoxone from the descriptions "looked like Coca Cola" and the effect on the lungs in particular.[[53]](#footnote-54) The involvement of the allotment society was not discussed in the newspapers, and the coroner worked hard to maintain the family's privacy. None of the surgeons involved in the transplant case would give any details, but the boy's uncle spoke to the press about what had happened.

During the same month that the transplant took place, The Mail's farming column reported that the Essex branch National Farmers Union wanted the danger of the product to be emphasised on the label. This was the first time the Mail explicitly associated paraquat with fatal poisonings.[[54]](#footnote-55) Later that year, paraquat left the confines of niche gardening, business and farming columns when fatal accidental poisonings started appearing as news items in their own right. The first was the death of 6 year old Beverly Pollitt, who drank paraquat from a lemonade bottle - this story appeared in the general news of the Times,[[55]](#footnote-56) and the Mail. This case was particularly interesting because the father worked for ICI and had asked another ICI laboratory worker with access to Gramoxone, to get some for him. This was an unusual situation and none of the other cases presented in newspapers had such a tight tie to the chemical company, other than the use of their product. Another article in the Farming column later that same year announced that liquid formulations of paraquat were going on the Home Office poisons list, but that Weedol was exempt.[[56]](#footnote-57)

The BMJ article on the Alex's lung transplant (although he wasn't named in the article, only described) noted that he "had no previous significant history and he was a well-balanced, intelligent, and stoic individual".[[57]](#footnote-58) It seems unusual for the character of a patient to be commented on in this way, as the newspapers tended not to include this type of adjectives. This case appears in Plant Protection Ltd's list of poisonings occurring in 1966 and 1967 which was submitted for review by the Scientific Subcommittee on Poisonous Substances Used in Agriculture and Food Storage. The Irish and Scottish incidents are described in a way that emphasises the human error in using the chemical, "patient was drunk when he consumed the chemical" and "a mentally retarded man drank Gramoxone in mistake for wine" as well as the explicitly prohibited behaviour, repacking, into beer bottles, and storing them among other drinks.[[58]](#footnote-59)

There was a big rise in paraquat poisoning stories from 1971 and I speculated that the trigger for the Daily Mail to start reporting on deaths was not necessarily that they were becoming more frequent, but that they were no longer just affecting adult workers. This could not be the case, because we've seen examples of accidental weedkiller (which is plainly gramoxone) related deaths of children and teens being reported. The BMJ editorial demonstrates that children had been poisoned from 1967, or perhaps earlier, so perhaps it was a critical/ mythical/ threshold number of children or people affected in accidental poisonings. Perhaps it was to do with a lack of clarity about regulations on sales, the presence of Weedol on the market and potential for domestic users to seek out paraquat and equate stronger with better, or just pure horror at how a chemical that could lead to such an agonising death could be so widely available. I need to do further research is needed to find out what this tipping point or change at the Daily Mail was.

Accidental poisonings as news items meant that paraquat left the confines of niche gardening, farming columns. These stories invariably conveyed the lack of effective treatment available, often with the stock phrase "no known antidote". This idea grabbed the imagination, and it was sufficiently frightening to sell newspapers, and prompt readers to write letters calling for it to be banned. Arsenic based weedkillers had been fatally poisoning people for much longer, and correspondingly progression and management of poisoning was better understood and accepted. As Boon wearily noted, this antidote statement was technically accurate, but it was not unusual as in the true sense of antidote where one chemical neutralises another, very few poisons have an antidote, not even aspirin. Boon attributed this phrase to an answer given to a coroner in court to the question whether an antidote was available.[[59]](#footnote-60) However, it was useful shorthand in newspapers for expressing the horror and despair that was experienced by victims, their families, and the medics who cared for them.

Newspaper articles at the start of the spate of accidental poisonings initially simply referred to 'weedkiller', which would be fair enough as swallowing any sort of weedkiller could be expected to have a life threatening effect. Indeed, civil servants lamented that they did not understand why the bipyridyl herbicides were singled out in this way.[[60]](#footnote-61) Then as the stories were elaborated on or became more numerous the identity of the weedkiller was presented. Each of these accidental poisonings could be attributed to the agricultural herbicide being taken from a workplace, some have said stolen, then stored and labelled inappropriately in a domestic environment. It was the chemical paraquat, rather than the brand name Gramoxone, that was held accountable. Only ICI made paraquat, they held the patents and it was a complicated process, so avoiding using the brand name but in naming paraquat, the company was implicitly named. The occasional use of the brand name disrupts the idea that papers might have been trying to protect themselves from the company.

**Protecting Users**

The chemical name Paraquat first appeared in Hansard in 1970, when Joyce Butler asked whether MAFF would withdraw approval for paraquat following a number of accidents.[[61]](#footnote-62) The answer was negative: there was no evidence that the chemical was harmful to workers, when used in accordance to the instructions. This was not the first time that Butler had spoken up in Parliament for users (and victims of) of agricultural and garden chemicals. Butler had been very active throughout the 1960s when DDT, aldrin and dieldrin came under closer scrutiny and public concern. She spoke out vociferously against the government produced booklet *Chemicals for the Gardener*, which contained recommendations to use these chemicals without further information about their persistence, which she argued was necessary should the garden user want to make an informed decision about the wider implications beyond ridding their garden of pests that season. Again, full responsibility was placed on the chemical users to read and obey the information provided by the manufacturer.

Butler represented Wood Green, which was later classed as Harringey. As an urban area, there wasn't any agriculture and therefore crop spraying, and no major chemical industry. Butler felt very strongly about intensive farming methods and environmental pollution, both of which were closely related to consumer issues, repeatedly calling for joined up thinking and better links between Government departments. She described herself as a housewife, although it was no ordinary household she was part of - her husband was a Labour candidate for Rutland but of the pair she was the more politically mobile, and influential, as a member of Wood Green Council, becoming council leader in 1954 then deputy mayor before becoming elected in 1955 as an MP for the Labour Party. She was willing and able to speak confidently and knowledgeably on technical scientific subjects, keeping abreast of research and policy development in the United States and passing material on for review to the relevant UK government body.

Butler focused on labelling of these chemicals with information that was relevant and comprehendable to the lay public. Over the course of Butler's political career, she would cover water fluoridation, chemical exposure to workers in industry, permitted chemicals in food and cosmetics and their labelling, environmental health, with a keen focus on users and domestic consumers. She consistently kept the issue of chemicals and consumers in debate, for instance questioning about insecticide use (HC Deb 22 November 1967 vol 754 cc357-8W), progress of regulations (HC Deb 01 May 1968 vol 763 c204W), DDT, the possibility of a housewives' ombudswoman (HC Deb 24 October 1967 vol 751 c449W) involvement of women's organisations with the Consumer Council (HC Deb 07 February 1968 vol 758 cc122-3W).

Butler's question about revoking approval, instead of an inquiry launched or health and safety procedures reviewed, looks like a knee-jerk or over-reaction in this instance, and an inflexible answer was given accordingly. Butler did not appear as a participant in further discussions about paraquat, but the weedkiller remained a topic of frequent questioning in the House of Commons until the 1980s, with figures on deaths attributed to the chemical being regularly requested by a number of MPs. Paraquat was an extremely effective weedkiller and the agricultural background that MPs and Peers came from personally, or represented constitutionally, were important in their arguments, as was the ability of Britain to produce enough affordable, safe food for a growing population. Jobs and income depended on the continued demand for paraquat in Britain and abroad, meaning that the MP for Widnes where ICI's paraquat factory was located appeared regularly in debate about the chemical. ICI's claims about product safety were never explored in this forum; the Pesticides Committee dealt with these issues in relative privacy. The strength of trade unions does not come through in these arguments, but safety organisations and committees, the Pesticides Review board (?) the British Council for Safety, the Royal Society for the Prevention of Accidents and the Health and Safety Executive were frequently referred to for figures and guidance, or in the case of the pesticides review committee, held up as the entire safety provision. The co-operation and relationships between these groups, the networks, connections and dynamics between members of these groups are not always clear from the discussions recorded in Hansard, though Butler expresses frustration at how they could work better together, with reference to the recommendations made in the "disastrous" Chemicals for the Gardener booklet (HC Deb 26 March 1964 vol 692 cc756-70) where outdated information (the chemicals had already been deemed dangerous) was provided. There was even a prisoner suicide using the weedkiller, though there was never any comment recorded about how he came to obtain the lethal dose.

**Experimental Users**

In 1972, marking ten years of paraquat on the market and six years since the first fatality, the Daily Mail took up the cause of accidental paraquat poisoning, focusing on the risk to children. The newspaper ran their own investigation into how easy it was to obtain Gramoxone and that controls on its retail were not working.[[62]](#footnote-63) They contacted spokespeople from Plant Protection, ICI, MAFF, as well as the pharmaceutical society, and were able to portray the chemical company positively, as working hard to make the formulation of the very effective and valuable herbicide safer, and investing in to find better treatments for poisoning. They kept a running totals of deaths, continued calling for better retail practices, clearer labelling, and more thorough governmental approval processes, while continuing to carry regular advertisements for Weedol and other ICI garden care chemicals. Later in 1972 the Mail carried their first report on suicide using paraquat, though we saw from the earlier slide that it had been used for this purpose for longer.

Occasionally for greater emphasis or connection with the reader, Weedol was mentioned as containing paraquat. To a casual newspaper reader without their own experience of the products, who were not closely reading stories spread out over time, it would be easy to come away with the idea that all paraquat products were somehow imbued with the intention of wreaking death.

The Daily Mail newspaper's active role in educating readers about the dangers of paraquat can be seen in the MAFF files, in the form of requests for information from their reporters. The files also show civil servants' reactions to articles from the Daily Mail and it shows them learning to anticipate what journalists would be asking for. There was a mixture of relief that the paper was getting across information about storing chemicals safely and following instructions for safe use, but also irritation that the journalists were misreporting and mangling other facts, even that they were appeared to be getting their information from sources other than MAFF.

MPs and Peers took it upon themselves to investigate; buying paraquat products, noting whether warnings were given by the seller or on the container, experiencing for themselves whether the information on the containers was hard to read, or easy to understand. A number of the participants in the parliamentary debates involving paraquat had experience of farming themselves, and were aware of the benefits of paraquat when used correctly as well as the tragic outcomes when it was not used as intended. Whether through mis-speaking, misunderstanding or absence of facts, Hansard records some continuing confusion about the appearance, availability and differences between agricultural and domestic paraquat preparations, so where personal experiences could be called upon they lent credibility and force to the arguments presented by those involved [REF]. An example of a confused statement is "The weedkiller Paraquat is, which is manufactured by ICI, is used fairly widely in down land districts. I do not know what it contains."[[63]](#footnote-64) Paraquat is "what's in it", the it being Gramoxone.

Extensive reporting of accidental poisoning was educational because people became more aware of \*why\* they shouldn't decant industrial strength herbicide into unlabelled bottles, and what the consequences could be of asking a friend for a bit of the amazing weedkiller from their work.

**Determined abusers**

Perhaps another consequence of reporting fatalities from accidentally ingesting the chemical was that deliberate poisonings started to occur more frequently. The role of paraquat in suicides was not explicitly mentioned in the mainstream press until 1972 when the Mail carried their first report of a suicide using paraquat. This followed their investigation earlier in the year into how easy it was obtain gramoxone.

The medical press had carried stories of suicides, from the very first and unusual suicide in Israel, as they correctly foresaw that the burden would fall to them. Generally, paraquat was drunk.

In 1973 Dr Matthew of the Poisons Board blamed what he called "disproportionate" media coverage given to paraquat deaths for the fact that in Scotland, the number of accidental deaths from paraquat was overshadowed by the number of suicides with the chemical.[[64]](#footnote-65) Weedol featured in numerous para-suicides; the reports in medical journals of this uses of the domestic chemical do not state whether the user knowingly chose this weaker form as a signal of distress, or because they were unaware that the paraquat reported on in most news stories was actually the more potent form Gramoxone.

Paraquat was not a special case, as suicide using to weedkillers was already an established practice. Michael Clarke pointed out in his study of suicides by poisoning, that as arsenic rat poisons were replaced on the shelves by nonarsenical formulations in the twentieth century, widely available arsenical weedkillers became the method of choice of those determined to obtain arsenic for the purposes of self destruction.[[65]](#footnote-66) The arrival of a new herbicide also provided a new chemical to poison oneself with, despite the lack of arsenic and many declarations that it was harmless (when used as directed).

Clarke discusses ease of death in his thesis, identifying those in the medical profession as choosing methods that would be as swift and painless as possible. Access to poisons demonstrated patterns where women used domestic substances such as disinfectants, agricultural and horticultural workers and that carbolic acid seemed to be used by residents of large towns.[[66]](#footnote-67) Users of paraquat were not just those with legitimate workplace access to the herbicide, In the use of and most deaths from paraquat poisoning were anything but easy. The agonising decline of patients was referred to in any article about the lethality of paraquat, communicating to would-be users that this was not an "easy way out", even if it was certain.

Murder was another misuse of the herbicide, as until \*\*DATE\*\* gramoxone didn't have an offensive taste or smell,[[67]](#footnote-68) so could it could administered in sherry, in cups of tea or mixed into stews without suspicion from taint or residue (arsenic left white powder in drinks and soups[[68]](#footnote-69)). Paraquat didn't have any special observable symptoms that would initiate detailed chemical analysis of blood or urine to bring the poison to light, and a poisoner could feign ignorance in order to delay or withhold appropriate treatment, ensuring success in terms of dispatch and remaining undetected.

In 1974 the first trial of a murder using paraquat, in the form of Gramoxone, was reported on. The Daily Mail followed that trial doggedly over 12 articles, while the Times only ran 2. Regardless of which paper carried the reports, the poisoners were described as adulterous, jealous men and women, in turbulent, unconventional relationships. Tabloid newspapers went into sordid, salacious detail. In two separate cases, the accused (and convicted) poisoners even stated that she had got the idea from a story in the newspaper.[[69]](#footnote-70) On this subject, newspapers remained quiet, despite the interesting question of their responsibility for copy-cat behaviour triggering. In contrast to the coverage of murders in newspapers, murder is barely mentioned in Hansard, where accidental poisoning and intentional self poisoning were the principle concerns.

One day before the Mail launched into nearly two weeks of daily court reports of a murder involving gramoxone, they carried an ICI advert with the tagline "Changes for the better, world wide".[[70]](#footnote-71) I wonder if this was an exercise in damage limitation by ICI, in which they aimed to reinforce the positive benefits brought by paraquat ahead of its central role in a murder trial, as well as position it as an agricultural chemical, not a domestic one. This tactic is only successful where people pay attention to advertisements, which in this case is not measurable. The articles concerning the murder, contained the information that the chemical was not meant for use in situations other than professional weed clearance, but none expanded on the social usefulness of the chemical or the manufacturer.

**Conclusions**

I have shown that Paraquat was enthusiastically received by niche newspaper columns. Gramoxone, although never intended by the manufacturers for domestic use *was* invited into some private homes and gardens, sometimes resulting in fatal poisoning. Deaths relating to paraquat were recorded from 1966, shortly after Weedol was widely marketed to home gardeners. The Daily Mail promoted the benefits of paraquat products in their garden advice columns and advertised Weedol at the same time as carrying stories of deaths involving paraquat. Overall, the number of deaths in relation to the total volume of paraquat sold and used was very small, the precautions were easily followed and the herbicide was extremely effective. This meant that ICI and regulatory government committees could not seriously contemplate a ban, although ICI were directed to, and did, investigate a variety of changes to the formulation, which resulted in adding Bitrex to deter people from drinking large amounts, and a chemical to make Gramoxone smell foul. Unintended uses of paraquat based herbicides brought the chemical to wider attention and media reports of these unintended uses, which for brevity and impact blurred the distinction between Weedol and Gramoxone, contributed to these uses being perpetuated.

Doctors communicated among each other about paraquat earlier than newspapers or politicians. It was vital that they did so in order to share information about treatment and likelihood of outcomes. Politicians bring up paraquat in their debates latest, although this is perhaps not surprising as civil servants have been dealing with the paraquat question competently for some time, politicians have least reason to be suspicious of government actions.

I thought it was interesting where poisonings were reported in the newspaper the chemical name, paraquat, was generally held accountable, rather than the brand names of the paraquat products. A critical point was reached in 1971, possibly the total number of fatalities, where that newspaper seemed to take up an educational role communicating the full dangers of paraquat to potential users and even existing users. This was possibly because ICI preferred to focus only on the adherence to their instructions for safe use and not give details of the consequences of not following their precautions.

In Weedol adverts that depicted a user, this imagined user did not match the image of the disobedient users who chose to bring the stronger version home.

1. [↑](#footnote-ref-2)
2. Bradbury, McCarthy and Suckling, “Patterns of Innovation Part III – The bipyridyl herbicides, *Chemistry and Industry*, 4 March 1972, p195; [↑](#footnote-ref-3)
3. ibid [↑](#footnote-ref-4)
4. Kennedy; Reade; [↑](#footnote-ref-5)
5. Bradbury; Wain [↑](#footnote-ref-6)
6. [↑](#footnote-ref-7)
7. Kennedy *ICI: The Company That Changed Our Lives* [↑](#footnote-ref-8)
8. “Killer chemical goes on Poisons List” DM 09.09.68, p6; “Menace of the weedkiller” DM, 11.05.72, p19; “The killer inside the bottle” DM 08.07.72 p20; “Should this killer be allowed?” DM, 30.08.72, p6 [↑](#footnote-ref-9)
9. Jealott's Hill 50 Years [↑](#footnote-ref-10)
10. Kennedy, p146 [↑](#footnote-ref-11)
11. Bradbury *et al*  [↑](#footnote-ref-12)
12. Wain, 1994, p140 [↑](#footnote-ref-13)
13. Kennedy, p146 [↑](#footnote-ref-14)
14. “Improved Type of Weed Killer” The Times, 23.08.62, p10.; “Farewell to the plough” Daily Mail, 29.08.62 [↑](#footnote-ref-15)
15. Kennedy ? [↑](#footnote-ref-16)
16. ICI success at Moscow fair 19.05.64, The Times, p18; SOS from Russia [↑](#footnote-ref-17)
17. Improved Type of Weed Killer, The Times, p 10, 23.08.62; Farewell to the plough, Winter, J., Daily Mail 29.08.62 [↑](#footnote-ref-18)
18. Jealott's Hill; How I transformed my pasture without the plough and got a higher milk yield, The Times, farming supplement p.ii, 07.12.64 and How I turned a problem field into productive pasture, The Times, farming supplement p.v 07.07.64 [↑](#footnote-ref-19)
19. Where have all the workers gone? P. Bullen, Daily Mail, 22.04.66 [↑](#footnote-ref-20)
20. Jealott's Hill [↑](#footnote-ref-21)
21. [↑](#footnote-ref-22)
22. '...and in the Toolshed' A Correspondent, The Times, 23.04.66, p13; 'Know your Killers!' MacKinnon, CA, The Daily Mail, 06.05.67, p9, [↑](#footnote-ref-23)
23. “Research the Springboard of Progress” The Times, 18.12.63, p.9 [↑](#footnote-ref-24)
24. Ideas in Action, also give details from series. [↑](#footnote-ref-25)
25. [↑](#footnote-ref-26)
26. MAF 284/289 15A, {IMG 3030} [↑](#footnote-ref-27)
27. Suckling and Langley, 1988, p510 [↑](#footnote-ref-28)
28. Vale et al, 1987 [↑](#footnote-ref-29)
29. “First in the field” The Times, supplement p. v, 02.07.63; “First in the field” The Times, supplement p.v, 02.12.63 These subtly different adverts did not actually mention the active ingredient paraquat, giving only the brand name Gramoxone W. The December advert identifies the product as qualifying for Ministry of Agriculture grants for pasture improvement. [↑](#footnote-ref-30)
30. “How I transformed my pasture without the plough and got a higher milk yield”, The Times, farming supplement p.ii, 07.12.64; “How I turned a problem field into productive pasture, without the plough” The Times, farming supplement p.v, 07.07.64 [↑](#footnote-ref-31)
31. MAF 284/289, 3B, Revised Draft SC 1029 JAR Bates, First Report on “Weedol” garden herbicide, Scientific Subcommittee on Poisonous Substances used in Agriculture and Food Storage, October 1961 [↑](#footnote-ref-32)
32. [↑](#footnote-ref-33)
33. [↑](#footnote-ref-34)
34. “Worth the extra pound or two” The Times, 07.09.68, p22. [↑](#footnote-ref-35)
35. "Chemicals threaten wildlife”, The Times, 17.12.68, p10 [↑](#footnote-ref-36)
36. Fifth report on paraquat - Home Garden Use, MAF 284 307, doc 108 {IMG\_2917} [↑](#footnote-ref-37)
37. [↑](#footnote-ref-38)
38. [↑](#footnote-ref-39)
39. [↑](#footnote-ref-40)
40. “The boy who thought he'd had a drink of pop”, Jane Gaskell, The Daily Mail, 24.06.71, p6. [↑](#footnote-ref-41)
41. SW 1169, 182, PNM Moore documenting a telephone conversation with Holloway 26.6.68, National Archives, Kew [↑](#footnote-ref-42)
42. "Weedkiller was nice, dying child whispered" The Times, 19.07.72, p2 [↑](#footnote-ref-43)
43. “The boy who thought he'd had a drink of pop”, Jane Gaskell, The Daily Mail, 24.06.71, p6. [↑](#footnote-ref-44)
44. [↑](#footnote-ref-45)
45. [↑](#footnote-ref-46)
46. Poisoning from Paraquat BMJ, Vol 3, No 5567, 16.09.67, p690-691 [↑](#footnote-ref-47)
47. Vale et al, 1987 [↑](#footnote-ref-48)
48. [↑](#footnote-ref-49)
49. MAF 284/307, 149, Letter from AAB Swan (Plant Protection Ltd) to F Stuart (Poisons Board) 16.02.68, National Archives, Kew [↑](#footnote-ref-50)
50. “Man drank weedkiller by mistake”, The Times, 11.12.69, p.5 [↑](#footnote-ref-51)
51. “Girl drinks first and dies”, Daily Mail, 30.09.72, p9 [↑](#footnote-ref-52)
52. “Boy with new lung winks at father” The Times, 18.05.68, p10 [↑](#footnote-ref-53)
53. “Boy and Girl in lung-swop operation” Daily Mail, 13.05.68 , p1; “Lung boy sits up for icecream”, Daily Mail, 18.05.68, p1; “Lung transplant boy dies” Daily Mail, 29.05.68, p1 [↑](#footnote-ref-54)
54. “Weedkiller Warning”, Peter Bullen, Daily Mail, 25.05.68, p4 [↑](#footnote-ref-55)
55. “Child died from weed killer” The Times, 14.08.68, p2 [↑](#footnote-ref-56)
56. Killer chemical goes on Poisons List, Peter Bullen, Daily Mail, 09.09.68 p6 [↑](#footnote-ref-57)
57. Matthew et al, BMJ Vol 3, no 5621, pp 759-763 759 [↑](#footnote-ref-58)
58. Scientific Subcommittee on Poisonous Substances Used in Agriculture and Food Storage [↑](#footnote-ref-59)
59. Kennedy, p.148 [↑](#footnote-ref-60)
60. [↑](#footnote-ref-61)
61. [↑](#footnote-ref-62)
62. “Should this killer be allowed?” DM, 30.08.72, p6 [↑](#footnote-ref-63)
63. Hastings, 1975, Hare Coursing Bill, http://hansard.millbanksystems.com/commons/1975/oct/24/duration-of-act [↑](#footnote-ref-64)
64. Extract from minutes of 66th Meeting of the Poisons Board, held on 23.2.73, Paraquat PB 998 IMG\_2643 - check Kew sequence to find file name [↑](#footnote-ref-65)
65. Clarke 1993, p271 [↑](#footnote-ref-66)
66. [↑](#footnote-ref-67)
67. Weed killer tasted nice said dying boy [↑](#footnote-ref-68)
68. Arsenic, King of Poisons? [↑](#footnote-ref-69)
69. '"I'll pole-axe you" a mother's shout at murder case', Daily Mail, 05.07.74, p13; “Poison stew wife is jailed for life” Daily Mail, 10.01.75, p3 [↑](#footnote-ref-70)
70. “Ideas in Action from ICI”, Daily Mail, 02.07.74, p5 [↑](#footnote-ref-71)