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Plant Protection Limited
ICI Agricultural Division

REPORT SERIES

M 2947 C

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CATEGORY C	

MINUTES OF THE FIRST MEETING OF PARAQUAT: REDUCTION OF HAZARDS BY FORMULATION PROJECT TEAM ON 14TH DECEMBER AT JEALOTT'S HILL.

Present: D Seaman, Project Leader.
E G Schumacher, Product Planning Dept., Fernhurst.
A H Gregory, Packages Adviser, Fernhurst.
D Wiseman, RATLS Section, Fernhurst.
D A Knowles, Works Experimental Dept., Yalding.
J Varley, Field Trials Section, Jealott's Hill.
J Downes, Patents Section, Jealott's Hill.
P D Bland, Formulation Section, Jealott's Hill.

Minutes prepared by D Seaman, P D Bland.

OBJECTIVES

The team agreed that the following objectives were acceptable.

1. To investigate all possible means of reducing accident hazards by formulation.
2. To develop the most promising formulations to the stage where they could be marketed if the company so desires.

The team recognised that there were alternative approaches to the problem of saving lives and maintaining 'Gramoxone' on the market and that the introduction of safer formulations might not be the means adopted. Nevertheless, this did not deter the enthusiasm of the team.

POSSIBLE SAFER FORMULATIONS

These are:

1. Incorporating stenches.
2. Thixotropic formulations.
3. Incorporating colour.
4. Incorporating bitter additives.

6080 wt

5. Incorporating emetics.
6. Water-in-oil emulsions.
7. Formulations with reduced uptake of paraquat into the body.
8. Solid formulations.

All of these formulations have their advantages and disadvantages. The major features are listed in Table 1. The team examined these features and recommends that no work should be devoted to emetics, water-in-oil emulsions and reduced uptake additives. They believe that the available effort should be devoted to developing the formulations which have been underway for a number of years now to improve them in every way possible. Work on solid formulations is not completely excluded as it was felt that solid formulations might be required in the long term as a last resort and that a higher production cost might be acceptable under these circumstances.

TABLE I. ADVANTAGES AND DISADVANTAGES OF THE VARIOUS POSSIBLE SAFER FORMULATIONS.

	Stenched	Thixotropic	Coloured	Bitter	Containing emetics	Water-in-oil emulsions	Reduced uptake	Solid
Is the formulation safer?	Debatable whether a stench is noticed quickly enough. Odour permeates present packs. The stench has a limited life, probably 1-2 years at 1% pyridine bases.	Yes provided the temperature is 25°C or below and provided the gel nature hasn't been removed by dilution with water. Above 25°C the product becomes fluid. Diluting it with a small amount of water is difficult.	Might save a life in some circumstances when 'Gramoxone' has been transfered to a clear or translucent bottle. Colour is an indication of danger.	Might occasionally save a life. Taste buds do not react quickly. If the solution dries round the neck of the bottle, the bitter taste might prevent drinking. Another indication of danger.	Would be safer if a suitable emetic existed. I.H.R.L. state that large quantities are required or they are too slow in action. I.H.R.L. advise there is little scope here.	These can be formulated from aliphatic oils e.g. diesel oil, which have a characteristic smell. Body can also be imparted. As for stenched and thixotropic formulations.	Leaving out wetters or changing to others can substantially reduce uptake into dogs. I.H.R.L. guess that this action would save some lives. It will be very difficult to find additives to reduce uptake further.	Probably the safest form. There have been no deaths from 'Weedol' granules even from suicide attempts.
Is the formulation acceptable to the registration authorities as a safer formulation?	Yes, although they would prefer a more pungent product.	Yes.	Probably in combination with other features.	As colour.	As colour.	Yes.	As colour.	Would expect so.
Is the formulation acceptable to the customer?	We expect so, although he might not like a more pungent product.	It is a big step backwards from the present product to have to shake the product vigorously. He also has to be careful that the gel has dissolved completely.	Yes.	Yes.	Yes.	As thixotropic.	Yes.	Much inferior to liquid formulations. Would have to take care to ensure product has dissolved.
Is the formulation acceptable for transport and stockholding?	Under investigation. Expected either to be not a serious problem or one which can be got round by using impermeable outer packages.	Yes except that the product occupies greater space than 'Gramoxone'.	Yes.	Yes.	Yes.	Probably as thixotropic and stench combined.	Yes.	Yes except that the product is likely to be more bulky.
What about production?	No problems forseen. Inexpensive modifications to packing lines required.	Expected to be straightforward but requires considerable plant modification.	Probably fairly straightforward.	As colour	As colour.	Quite different from present Mond method.	As colour.	Completely new formulation process required. Could be costly.
Is extensive work required to produce such a product or improve on the present product.	Considerable but not enormous effort required. Bottle impermeable to stenches required.	Very considerable effort probably required to make major improvements. The ideal product would be one of which did not require ullage, required a minimum of shaking, had good dilution properties and temperature independent rheology. The ideal is probably not attainable.	Very little done to date. Should be simple in a thixotropic formulation but could be difficult in a liquid.	This line would not be pursued if it proved difficult.	Yes.	Work along these lines has been limited. The best product to date has inferior biological activity to 'Gramoxone'. Much formulation, biological and process development required. Not compatible with enhanced activity formulations.	Yes.	More concentrated 'Weedol' type product could be evaluated with a minimum effort. Other alternatives e.g. paraquat/iron chloride complex would be major pieces of work.
Can the system be patented?	The specific system is being patented.	We are hoping to patent thixotropic formulations in general.	May be possible for specific systems.	May be possible for specific systems.	May be possible for specific systems.	The system is being patented.	Would expect considerable scope.	Would expect considerable scope exept perhaps for 'Weedol' type processes.

SHORT TERM TARGETS

After considering all of the constraints on the development of a safer paraquat formulation the team decided that a formulation approved by the Ministry of Agriculture could not be available for marketing before 1974.

Accordingly the team proposed it's short term target should be TO HAVE AVAILABLE IN 1974 A THIXOTROPIC, A STENCHED AND A THIXOTROPIC/STENCHED FORMULATION FOR MARKETING IN U.K. The team expressed a preference for the stenched formulation to be marketed in 1974 if the company wishes to introduce a safer formulation then. This preference is based on the following factors.

Factor	Stenched formulation	Thixotropic formulation	Thixotropic/Stenched formulation
Raw materials	Pyridine base readily available in quantity.	Supply of 'Kelsan' of consistent quality and quantity would have to be assured.	As for thixotropic and stenched.
Plant modification	Improvement of ventilation on packing and filling lines only.	Expenditure of £150,000 on plant modification.	As for thixotropic and stenched.
Packaging	In the short term the stench could be contained by metal foil overwrapping of the bottles, should this prove necessary.	Change of pack size or pack fill required.	As for thixotropic and stenched.
Registration	Clearance requires taint test results. Approval by the Ministry of Agriculture unlikely to be a problem.	Approval by Ministry will require further evidence of comparable activity to that of 'Gramoxone' W.	As for thixotropic and stenched.
Biological Testing	Taint tests on potatoes, kale, top fruit and strawberries.	Biological efficiency trials against 'Gramoxone' W.	As for thixotropic and stenched.
Customer acceptability	Very little difference in farmer handling.	Farmer handling difficult and could discourage sales.	As for thixotropic and stenched.
Compatability with enhanced activity formulations.	Unlikely to produce significant technical problems whichever formulation is chosen for 1973 trials. Likely to have a more active stenched formulation by 1974.	Modification of formulae required as wetter/additives affect gel strength. It will be extremely difficult to have a more active thixotropic formulation available by 1974.	As for thixotropic and stenched.

Factor	Stenched formulation	Thixotropic formulation	Thixotropic/Stenched formulation
Effect of temperature	Only affect rate of permeation through bottle walls.	Becomes fluid at higher temperatures, i.e. above 25°C.	As for thixotropic.
Safety aspect.	Better than 'Gramoxone' W but not the ultimate.	Safer than stenched formula at up to 25°C.	Safest of the three.
Dilution properties.	As for 'Gramoxone' W.	Satisfactory if instructions are carefully followed.	As for thixotropic.

The paraquat enhanced activity project team also has the launching of a new formulation in 1974 as its target. While incorporating a stench in the 'enchanced activity' formulations is unlikely to raise any fundamental problems, incorporating thixotropy in the enhanced activity formulations is likely to involve more technical effort due to the thixotropic nature of the new wetter/additive formulations themselves. It will be extremely difficult to dovetail the two projects with a target of introducing a thixotropic/enhanced activity formulation in 1974. A short list of enhanced activity formulations will be available by the end of February, 1973, and thixotropic enhanced activity formulations will have to be developed in the laboratory and ready for field trials in mid-April, 1973, if they are to be available for marketing in 1974.

The discussion to date has dealt with the U.K. market. The project team recognises that one of these formulations might be required soon after the U.K. launch in other countries, temperate and tropical. Detailed planning is required to ensure that any necessary field testing is carried out in these territories and that formulations containing 10% wetters (Gramoxone 'Export') for temperate and warmer climates are available.

ACTION PROPOSED

1. Mond Division to modify their plant to be able to manufacture a stenched formulation in 1974.

2. Packaging Section to develop a suitable metal foil overwrapper or lined carton to contain the stench.

3. Field Trials Section to arrange taint and biological efficiency trials in 1973 to provide enough information for clearance and Ministry Approval of stenched and thixotropic formulations. They shoud also liaise with UKDD on further testing.

4. A decision on expenditure of £150,000 to modify plant at Mond Division to make the thixotropic formulation to be made by the end of April, 1973 at the latest after the results from the Eire marketing exercise are received if the thixotropic formulation is likely to be required for 1974.

5. Farm Sales should organise customer acceptability trials in 1973.

6. A sub-group should be formed consisting of PDB, DAK and JV to arrange the details of the overlapping aspects of this team and the enhanced activity team.

7. R and TLS should advise Regional Technical Managers in which countries biological and taint trials should be undertaken in 1973. WED to check our formulations containing 10% present wetters with stench and with present level of 'Kelzan' and higher levels for hotter countries e.g. Italy, Israel.

LONGER TERM TARGETS

The safety of a formulation is improved by a combination of safety features. If it proved to be possible to incorporate colour and bittering agents into the three formulations under development, then this should be adopted. The following combinations were considered worthy of study.

1. Stench plus colour.
2. Thixotropic plus stench plus colour.
3&4. 1 and 2 plus bittering agents.

The prefered colour is blue as this colour is rarely used in foodstuffs and drinks and is used in pharmaceuticals to denote that the product is not to be taken.

A bottle is required which contains stenches within the formulation. A detailed investigation could lead to the choice of a suitable material which might be plastic or metal based.

There is some scope for investigating stenches further to come up with a stench or combination of stenches which is more pungent.

The thixotropic formulation is technically difficult to improve but is the safest formulation on the present short list. The aim should be to produce a formulation using as may be necessary alternative gel systems which will retain the properties which make it difficult to pour from a beer bottle but which will be easier to dilute, easier to fluidise in a full pack and will have improved temperature and storage stability over the present system.

As an ultimate target the combination of all four formulations in their improved form is aimed at.

The team also considered the situation if registration authorities banned liquid formulations of paraquat completely. It was considered short sighted to remove all effort from solid formulations on the basis of cost as it may well be the only feasible product in the final event. It was therefore decided to do a preliminary costing exercise based on the known manufacturing costs of 'Weedol' granules and expend a minimum of effort to determine whether a formulation containing 10% ion having better solution rate than 'Weedol' might be feasible.

ACTION PROPOSED

1. W.E.D. to investigate inclusion of colour and bittering agents in thixotropic and stenched formulations (target introduction 1975).

2. W.E.D. to look for more pungent stenches (target introduction 1975).

3. W.E.D. to investigate the improvement of the gel/temperature characteristics of the present system (target introduction 1975).

4. Packages Section to develop a bottle which contains the stench in the 'Gramoxone' solution (target introduction 1975).

5. Formulation Section, Jealott's Hill to investigate the mechanism of gelation and to investigate alternative systems with a view to discovering a product not requiring ullage, having good dilution properties and which gels over the required temperature range (targe introduction 1976).

6. Formulation Section, Jealott's Hill or W.E.D., Yalding with Product Planning Department to investigate and cost 'Weedol' type processes as a possible means of preparation and a guide on cost of solid formulations.

Note that the target years are very speculative and depend very much on overcoming difficult technical problems. X Too long

CONSTRAINTS

It is abundantly clear that there is insufficient manpower available to attend to both the short term and longer term targets as set out here. Extra manpower is required both on the packaging and formulation areas. The effort available may be strengthened in various ways. Manpower within PPL could be increased by recruiting or facilities and manpower could be asked for at Mond Division, Plastics Division and Corporate Laboratories. Background work could be placed with universities or polytechnics or other research institutions. The project team has not yet defined in detail its requirements. It awaits in the first place approval for its targets. Approval will imply that the company will make available in one form or another, the manpower and facilities required.

It is also abundantly clear that the co-ordination of this project team requires more effort than the present team leader can allocate to the project. The project team will not meet its targets if the position of the project team leader is not alleviated. Again there are a number of courses which could be adopted.

1. Appoint a full time project team leader.

2. Share the leadership with a member of Product Planning Section.

3. Provide the project team leader with a deputy to share the running of the project and/or his section.

Copies to:

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DS/PDB/CMH
18 Dec 72