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Pesticide exposure and sprayer design: ergonomics evaluation to reduce pesticide exposure

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Abstract. Plant protection products are used in agriculture to improve yields, but this use can cause contamination of the environment and is also likely to have adverse short and long term effects on agricultural workers. This poster describes a systems approach to reducing the risk of operator exposure to plant protection products through the introduction of ergonomics to the design process of large agricultural sprayers.

Keywords: equipment design, ergotoxicology, prevention, contamination

1. Introduction

Plant protection products are used in agriculture to improve yields, but this use can cause contamination of the environment and is also likely to have adverse short and long term effects on agricultural workers health (Dosemeci et al., 2002). Many factors in the work environment among which the type of pest control activity performed, method of application used, personal hygiene habits (frequency of changing clothes, washing hands ...), personal protection equipment have been shown to influence operator exposure (Aprea et al. 2004, Baldi et al. 2006; Le-bailly et al., 2009). The French government has initiated a long term program, Ecophyto 2018, to reduce pesticide use and to introduce work practices to limit spray operator's exposure. Only an integrated approach that takes into consideration training, personal and spray equipment design, and information on best practice will have a long term effect. It is suggested that a systematic ergonomics evaluation of sprayer interfaces with the view of reducing direct and indirect operator contamination will inform sprayer manufacturers in the design of new equipment with safety in mind. A short survey of sprayer manufacturers at an international exhibition of agricultural

machinery revealed that out of 14 consulted 5 consider that it is their role to take operator exposure into consideration, 8 understood that operator safety is a problem but conforming to safety standards was a sufficient response and 1 who considered operator safety as not part of its brief. Here, we propose a methodology to evaluate sprayer design solutions in terms of safeguarding agricultural workers from contamination from pesticide mix during sprayer operation.

2. Methods

The ergonomics evaluation follows 3 main steps:

- An activity analysis of operator's work during the whole spraying process from mix preparation to sprayer cleaning in order to identify probable contact sites.
- An ergonomics inspection of sprayer interfaces that examines, under different criteria, the different parts of the sprayer that can come into contact with the operator during the preparation and application of pesticides.

- The application of a risk evaluation technique -Failure modes, effects and criticality analysis (FMECA), where the definition of failure is a contact event leading to pesticide exposure.

3. Results

The results from an initial telephone survey of agricultural workers determined which sprayer parts were considered as problematic. A summary of operator activity represented on a flow chart was derived from 7 activity analyses recorded during pesticide spraying in Bordeaux vineyards. Each action related to the mixing/loading, application and rinsing phases was recorded and the potential contact points identified.

A file for each of the main individual components that the operator uses on the sprayer was documented. Each component was considered in terms of four main criteria - accessibility, force required to operate, visibility, and potential chemical risk when operated. Each file consisted of a description of the part, and photos of examples from different models of sprayer. A summary of operator activity represented on a timeline provided the basis for decomposing the treatment phases and defining the stages in a FMECA analysis. The analysis was performed with currently used spraying equipment as examples of specific design solutions for the different parts of a sprayer.

4. Discussion

The evaluation of different models of sprayer used by French vineyard workers has identified serious design faults in terms of worker's potential contamination.

The summary of the results has been presented to an industry working group with the view of including an ergonomics approach to future sprayer equipment development that will take into consideration operator work activity and health, and reduce the potential of exposure. A number of challenges were identified in choosing suitable ergonomics evaluation criteria that could be implemented in a FMECA for a pesticide sprayer.

5. Conclusion

The risk evaluation technique has proved a useful complement to classical ergonomics evaluation techniques. Further work is planned to test other methods from accident analysis and risk evaluation practice.

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