Herbicide application: an important factor in herbicide efficacy

Hossein Najafi
PO Box 31585-488, Karaj, Iran
Iranian Plant Protection Research Institute, Weed Research Department
Corresponding author: najafiamir@yahoo.com

Summary Herbicide application equipment is required to deposit plant protection products as safely and accurately as possible on target. In most developing countries, there are few examples of routine testing and certification of sprayers and the process of delivering pesticides to the target is not well understood nor is it generally well managed. A number of factors contribute to this situation, with poor knowledge being the most important factor. Lack of adequate policies and legislation, and socio-economic problems are other factors that contribute to this situation. A study of herbicide application methods in Iran also indicated that lack of knowledge is the main reason for deficiencies in herbicide application practices – 84% of farmers did not have any information about sprayer calibration. In addition, 76% of sprayers did not have a pressure gauge or their gauges were damaged. In addition, 68% of operators used different nozzles at the same time in the boom.

Keywords Sprayer, maintenance, safety, herbicide efficacy.

INTRODUCTION

There are many factors that affect herbicide efficacy. Herbicides must be applied accurately and uniformly to an area of land or foliage to be effective. Improved accuracy can be achieved by proper calibration and operation of herbicide application equipment. Agricultural herbicide application equipment is required to deposit plant protection products as safely and accurately as possible on target. The aim is to deliver only the dose that is are required to control the pest and to minimise contamination of the operator and off-target losses into the environment (FAO 2001). Some scientists suggest that only 1% of the pesticides used worldwide actually reach their target (Pimentel 1995), and because of this, herbicide application equipment and methods are two important factors for increasing herbicide efficacy and human safety. Over-dosing/uneven dosing, unintentional spreading of herbicides into the surrounding environment and exposure risks for users are three problem areas that can be solved by better application technology. This requires a good understanding of the target weed, herbicide, method, equipment and operator (Hagenvall 1994).

Most developing countries do not have programmes for routing testing and certification of sprayers. Lack of knowledge at all levels has also been identified as the main reason for deficiencies in pesticide application practices (Friedrich 2001). In addition, there have been numerous reports of adverse effects of pesticides on the health of farm workers in different countries. In Europe the use of herbicides and related spray equipment is increasingly controlled, and drift considerations are leading to strict regulations. Contrary to this, in countries without such legislation, bad practices are common. Modern herbicides have reached the most remote parts of the world, but the technology used for their application often reflects technologies used 40 years ago. This results in a waste of herbicides, damage to non-target plants, decrease of herbicide effectiveness, unnecessary environmental contamination and extensive health hazards for humans and wildlife. In the absence of specialised knowledge and equipment, unsuitable technology is used for specific spray operations with the result that herbicides are not properly delivered to the target. The aim must be to optimise the amount of herbicide deposited on the intended target with minimal losses elsewhere. Unfortunately, most sprays contain a large number of droplets that vary in size, so some contain too much herbicide, while others may be too small and are particularly prone to movement outside a treated area. This spray drift needs to be avoided wherever possible (Matthews 2000) as it leads to a high wastage of herbicides and hazards for operators and environment. Reports produced for FAO in several world regions have identified problems of sprayer quality. Particularly with used sprayers, operator contamination through leakage from different points of the sprayer was very common (Friedrich 2004). However, even with new sprayers it seems to be difficult to have a completely leak-free sprayer. Existing standards for knapsack sprayers often assign a certain limit to the maximum permissible leakage, which is usually larger than 0 mL (FAO 2001). Leaking knapsack sprayers are particularly dangerous as a survey carried out in Cameroon showed that 85% of operators do not use protective clothing (Matthews *et al*. 2002). Self-harm and pesticide poisoning are such great problems in Sri

Lanka that the President set up a special commission in the mid 1990s to advise on ways to reduce the country's high rate of suicide. In 1995, self-harm was the main cause of death nationally in the 15–24 and 25–49 year age-groups. Pesticide poisoning was the sixth commonest cause of hospital death in Sri Lanka, with 1571 deaths and 15,730 cases (Eddleston *et al*. 2002).

Apart from poor quality, inadequate maintenance is another reason for safety and environmental hazards caused by sprayers in developing countries. Sprayers are usually in very bad condition, and nozzles and gaskets are hardly ever replaced (Whitaker 1993).

The objective of this study was to evaluate sprayers that are being used for weed control in agricultural fields and to examine herbicide application methods in Iran.

MATERIALS AND METHODS

During 2004–2006, five provinces (Tehran, Khorasan, Fars, Golestan and Azarbayejan) were selected for voluntary inspection of field crop sprayers. Approximately 5800 field crop sprayers were identified as being used for weed management in 2004. Almost 5% of these were active in each location and their operators were selected for testing. In total, 287 sprayers were tested. Each individual sprayer was evaluated for different elements of the herbicide application process that were potentially hazardous. These included characteristics of the equipment (including sprayer equipment selection, check of spray equipment before use, nozzle type, pressure gauge and valve accuracy, leakage and calibration) and of the operator (including knowledge and training).

RESULTS

The type and quality of equipment are the most important factors that affect herbicide application uniformity. Results of this survey indicated that only 46% of sprayers were checked before herbicide application by farmers (Figure 1). Similarly, in a study in Germany, only 50% of the equipment was found to be in good working condition, and therefore the government decided to introduce mandatory checks (Wehmann 1993). A report from Malaysia noted that 48% of knapsack sprayer tanks surveyed were dented or cracked, while a similar report from Pakistan and 15 West African countries noted that leaking tanks of knapsack sprayer were a significant source of operator contamination (Friedrich 2001). In our survey, 84% of operators didn't calibrate their sprayers before spraying (Figure 1). Calibration will ensure that the chemical needed for optimal weed control is spread uniformly over the specified area and is necessary for effectiveness of herbicide. Proper calibration will save farmers money through reduced weed control costs.

As mentioned before, herbicide application uniformity depends on several factors, such as type and quality of equipment. While the introduction of

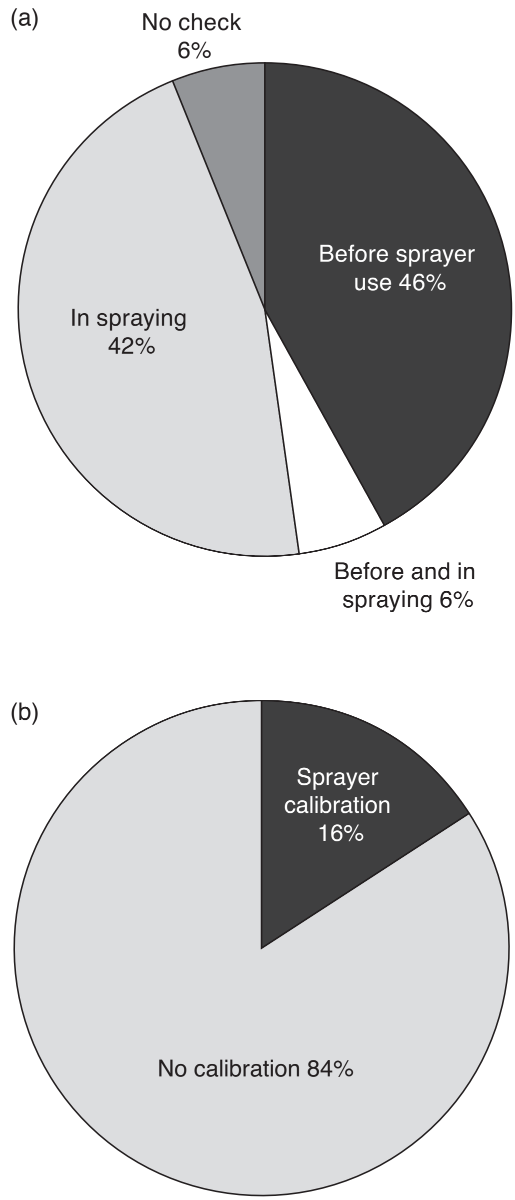

Figure 1. Proportion of sprayer operators that (a) checked sprayer before or during spraying and (b) calibrated the sprayer before herbicide application.

mandatory periodic inspections of sprayers is likely to result in an increase in herbicide application uniformity, this process must be carried out in a step by step approach, initially targeting the most critical areas of the sprayer and then expanding to all parts of the sprayer equipment.

A critical component of all sprayers is a pressure regulator. This controls the sprayer system pressure and sprayer output through the nozzles. Most sprayers were found defective in pressure gauge accuracy. The investigation also showed that 76% of sprayers did not have a gauge or their pressure gauges were damaged (Figure 2).

Nozzles were another element that were examined in this study. Our observations found that different kinds of nozzles were installed on a single boom in many of the sprayers selected for testing (Figure 3). There are reports on differences in droplet sizes obtained from nozzles produced by different manufacturers (Matthews 2000).

Skill of the operator is another factor that will affect herbicide application uniformity and herbicide efficacy. Unfortunately, practical training of farmers and equipment operators was very low (Figure 4) and this is very unsatisfactory. Lack of knowledge has been identified as the main reason for deficiencies in herbicide application practices (Friedrich 2001). The occasional training courses given to extension workers in Iran and many developing countries have not any impact at all and a long-term education strategy is required. A system for authorisation of herbicide users would be an important step towards enhancing herbicide effectiveness. This type of system would mean that all farmers and other people who want to (a) apply any type of herbicide, (b) operate a sprayer professionally or (c) are buying or selling sprayer equipment would have to be authorised.

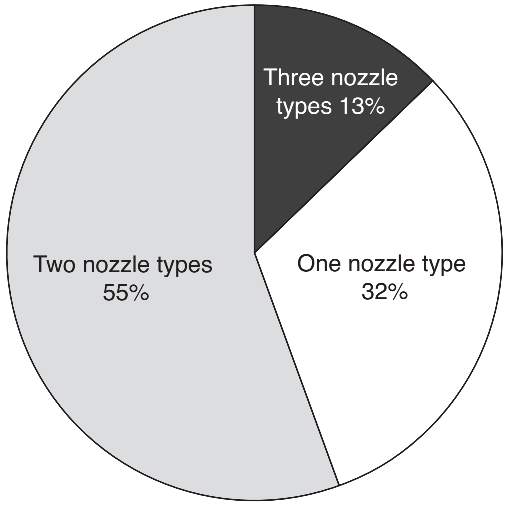

Figure 3. The proportion of booms with one, two or three different types of nozzles.

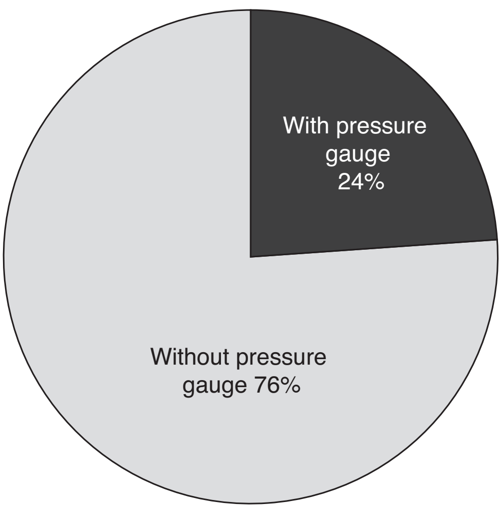

Figure 2. The proportion of sprayers that had a pressure gauge installed.

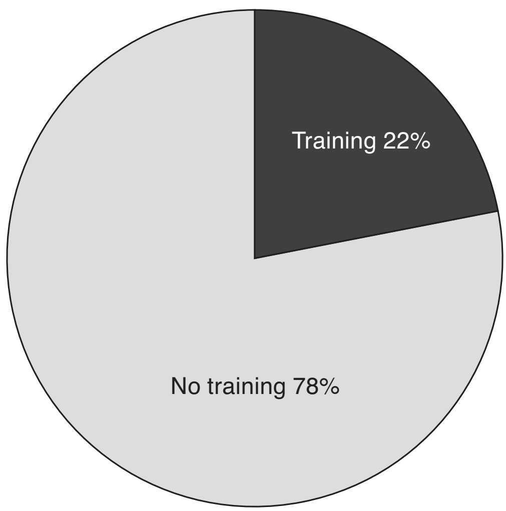

Figure 4. The percentage of operators that had passed a practical training test.

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