Leaching potential of fenoxaprop-p-ethyl and pendimethalin in silty loam soil

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Introduction

Leaching is an important process that influences the fate of pesticides in the environment. Generally more polar in nature, herbicides have more leaching potential than insecticides and fungicides. Herbicides being frequently reported in ground and surface water have raised serious environmental safety concerns (Bernard et al., 2005). Pendimethalin is categorized as a non-leaching and persistent herbicide (Chopra et al., 2010; Zheng et al., 1993), however, very limited information is available about its environmental fate. Fenoxaprop-p-ethyl is a selective herbicide used to control wild oats in wheat, canary grass in barley and control annual and perennial grass weeds. Fenoxaprop-p-ethyl is widely used because it effectively controls the weeds and has low environmental toxicity. However, limited data is available about its leaching behaviour in different soils.

Due to injudicious use of pesticides, the lack of a pesticide usage database and improper monitoring systems, it is always difficult to carry out risk assessment and environmental monitoring studies in developing countries. In the present study, therefore, we aimed to investigate the leaching potential of the herbicides commonly used in the region. We employed silty loam soil columns to examine the leaching potential of the pendimethalin and fenoxaprop-p-ethyl with atrazine as a reference compound.

Material and methods

Silty loam soil (1.10 % organic carbon) was collected from a cultivated field (Peshawar, Pakistan). The site had not been subjected to pesticide treatments in the last 5 years. Soil pH, electrical conductivity (EC) and organic matter content was measured prior to the leaching experiment. Soil was collected separately from three different depths, 0-15, 15-25 and 25-35 cm. The soil was packed in the polyvinylchloride (PVC) drainage pipes (height 38 cm, diameter 5 cm) in such a way that represented the depth profile at the sample site.

Analytical standards of the individual herbicides; atrazine, pendimethalin and fenoxaprop-p-ethyl were applied to the columns separately. All the pesticides were applied in a single dose at different application rates. Thus, atrazine (400 µg) was applied at maximum recommended application rate (X), fenoxaprop-p-ethyl at 200 µg (X) and 400 µg (2X), while pendimethalin at 300 µg (X) and 3 mg (10X) levels. All the columns were irrigated weekly with 90 mL of CaCl₂ solution (0.01 M) as an artificial rain assuming worst case scenario and leachates were collected after each irrigation for 14 weeks, while leachate from the aged residue soil columns were collected after the application of 2 L of artificial rain as a single dose. Pesticides were extracted from the leachates via solid phase extraction followed by a reversed phase high performance liquid chromatography for both qualitative and quantitative analysis.

Results and discussion

Atrazine was found to be the most mobile of the three compounds and was detected in almost all of the leachates from week 1 to week 12. By contrast, no pendimethalin was detected in the leachates collected from soil cores treated at X application rate. Pendimethalin was, however, detected in the leachates collected during weeks 11 and 12 from the soil cores treated with 10X of the recommended application rate. Fenoxaprop-p-
ethyl was detected in all the leachates collected from weeks 4 to 7 from the soil cores treated with X, while from week 3-9 from the soil cores treated with 2X recommended application rate (Figure 1). Fenoxaprop-p-ethyl and its transformation products (TPs) have been recovered from the leachates of the aged residue experiments. Neither pendimethaline nor its TPs were found in the leachates of the aged residue (results are not shown).

It can be concluded that pendimethaline strongly binds to the soil particles and has a low leaching tendency in silty loam soil when compared with fenoxaprop-p-ethyl, even at a very high application rate. Accordingly, fenoxaprop-p-ethyl is a greater potential risk to ground water contamination even at recommended application rates and should be monitored in both ground and surface waters.

References

