RESEARCHERID THOMSON REUTERS

International Journal of Research in Engineering and Applied Sciences(IJREAS)
Available online at http://euroasiapub.org/journals.php
Vol. 14 Issue 9, Sep -2024,
ISSN(O): 2249-3905, ISSN(P) : 2349-6525 |
Impact Factor: 7.196| Thomson Reuters ID: L-5236-2015

Leaching behaviour of Oxyfluorfen Herbicide in two texturally different soils

Sameena Rani[1], Anil Duhan[2], Naincy Rani[3]

[1]Ph.D. Chemistry, Department of Chemistry, Shri Jagdishprasad Jhabarmal Tibrewala University, Rajasthan, India

[2]Scientist, Department of Chemistry, Chaudhary Charan Singh Haryana Agircultural University Hisar, India

[3]Ph.D. Chemistry, Department of Chemistry, Chaudhary Charan Singh Haryana Agircultural University Hisar, India

DOI:euro.ijreas.55412.33265

Abstract

Use of oxyfluorfen as pre or post- emergent herbicide creating the need to assess its environmental fate. Leaching potential is method to find the movement of herbicides in soil. A empirical research was carried out to study the leaching behavior of oxyfluorfen in sandy loam and clay loam soil under continuous flow conditions. Oxyfluorfen was applied in the soil at two application rates 250 µg/g and 500 µg/g. The flow of oxyfluorfen particles in soil was analysed at different depths interval of 5 cm viz, 0-5, 5-10, 10-15, 15-20, 20-25, 25-30 cm depths. Residues of oxyfluorfen in soil was analysed using GC-MS tandem mass spectrometry. It was observed that, beyond 90% oxyfluorfen particles absorbed in uppermost 5 cm soil surface in both soils. Oxyfluorfen leached up to 10 cm soil horizon and almost whole applied herbicide persist in upper layer of soil column. Hence, oxyfluorfen did not exist any hazards of polluting the ground water when utilized at proposed rates.

Keywords Oxyfluorfen . Leaching. Sandy loam, Clay loam, QuEChERS

1. Introduction

Crop losses due to weeds is a major concern in agronomy where demands for foodgrains is increasing but availability of resources are limited. The use of herbicides application cannot be neglected in agriculture for crop protection. Tudi et al. (2021) observed that about one-third of agricultural commodities are generated by the use of toxicant application. A selective use of herbicides have effective weed control as provide a flexibility toward modern agriculture techniques. The virtue of herbicides in agriculture reduces the time consuming in manual methods of weed control. The convenient nature of herbicides makes its utility in agriculture economy. The continuous use of herbicides for long time make the negative effects on environment(Tandon et al.2017).

Despite the utmost importance of herbicides there are some drawbacks like herbicide residues remain in soil, groundwater contamination and phytotoxicity. Herbicides residues reaches at groundwater through leaching and runoff. leaching is the major origin of ground water pollution by weed killers (Sondhia 2009, Flurry 1996). A long- time persisted herbicide with high mobility increases the threat of pollution of water bodies and ground water (Tandon et al. 2016).

Oxyfluorfen is chemical compound that exist in yellow colour in its liquid phase (Figure 1). At normal temperature oxyfluorfen also exist as crystalline solid. It is an aromatic ether. It has low water miscibility of 0.1 mg/l and vapor equilibrium force is 2×10^{-6} mm Hg at normal temperature. It has lethal dose 50(rat) of > 500 mg/kg.

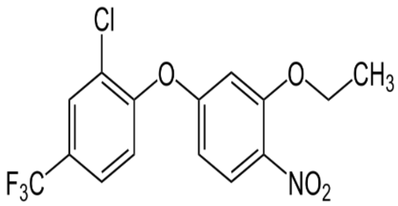


Figure 1: Oxyfluorfen

Oxyfluorfen is pre and post emergence herbicide which is used for grassy and broad leaves weed species (P.Janaki et al. 2013; Sondhia and Dixit 2006; Sondhia 2010).Oxyfluorfen has high binding capacity with organic matter and clay content of soil(Laura Scrano et al. 2004). Oxyfluorfen herbicide belongs to diphenyl ethers herbicides family which are photosynthetic inhibitors and also exert the cytotoxic effect on human hemoglobin. Oxyfluorfen has impact on the land flora and water environment as it is unsafe for the plant, invertebrates and aquatic organisms (Oxyfluorfen RED Facts. 2002). Oxyfluorfen can pollute the water bodies through spray flow and drainage (USEPA, 2002) and is classified as it is unsafe for the amphibious organism (EFSA, 2010). K. M. Durga Devi et al. (2015) reported the leaching behaviour of oxyfluorfen and other toxicants in Kerala soils. Tandon, S (2018) reported the leaching potential of oxyfluorfen in clay loam soil under saturated moisture condition. Arora A (2017) observed the leaching action of oxyfluorfen in FYM amended and un-amended sandy clay loam soil. In India oxyfluorfen herbicide is used in various crop like onion, radish, potato, chickpea, maize, garlic and groundnut. Thus, the substantial use of oxyfluorfen herbicide in various type of field crops (Thakare et al. 2002, Sondhia and Dixit, 2007) is unknown about its leaching movement to infect the ground water under rainy environment. Therefore, the existing research work study the leaching potential of oxyfluorfen herbicide in two textured soil i.e. sandy loam and clay loam soil.

2. Material and Methods

Two types of soil were collected from different places which was not served by any toxicant application. Sandy loam soil was taken from the C.C.S.H.A.U. Hisar and clay loam soil was taken from the K.V.K. Fatehabad (at 10-25 cm depth). Soil were air dried, pulverize into the ultrafine and filtered by a strainer before use. The molecular characteristics as per the approach recommended by Sherrod et al. (2002), Rayment and Lyons (2011).

Molecular characteristics of Soils	Sandy loam Soil	clay loam soil
pH (H_2O)	7.8	8.8
Coarse sand	56%	48%
Silt	29.20%	18%
clay	14.80%	34%
E.C.(ds/m)	0.19	0.18%
OC(%)	0.30%	0.48%

2.1 Leaching Experiment

The experiment was conducted in Agrochemical residue testing Laboratory CCS HAU, Hisar in March, 2020 studied the leaching behaviour of oxyfluorfen herbicide by using plexi columns (60 cm long with 3 cm internal diameter) equipped with glass sieve and protected with chromatography paper at lowest part. All columns were packed with soil up to 40 cm height to a consistent bulk density of 1.50 g/cm^3. Measured quantity of soils, i.e., 53 g soil was streamed gently in the column from a fixed height and pressed identically by a wooden roller. This technique was performed again up to the time that all columns was perfectly packed to a height of 40 cm. The standard solution of oxyfluorfen ranging from 1µg/ml was used for this leaching experiment. Oxyfluorfen solution was diluted with the 10 ml water added directly applied to the surface of column at 250 µg (T_1) and 500 µg (T_2). To avoid any disruption in the column Cotton ball pre-rinse with acetone were implanted in the middle of column soil and herbicide treated soil and the upper section of the column. Columns were kept as three replicates of application dose and one as control that was never treated with herbicide. All the Soil column was leached with of pure water. In all columns 50 ml of pure water was poured by using chemical droppers, with the concern that no disturbance was occurred in soil. Now the columns were leached again with 50 ml of pure water after the interval of 1 day for dissipate the remaining water in the column. To avoid evaporation in leaching these columns were protected with pierced plastic bags which help in reduce the loss of leaching water.

- **Chemical Analysis**

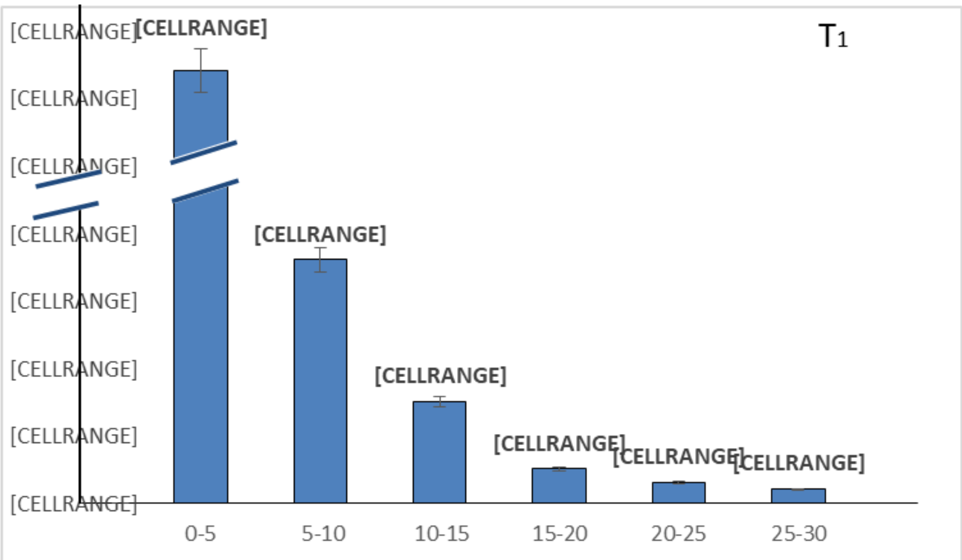
Subsequently the leaching process, perfect soil cores were isolated from acrylic column. These soil cores were cut into 5 cm long segments each. These segments were dried completely, crushed and strained prior to analysis of oxyfluorfen. The extraction of herbicide residues from all soil segments were analysed by the modified QuEChERS process as suggested by Rani et al. (2020). Different 50 mL draw tubes were used for soil samples and swirled with acetone. The blends were shaken for 1h on mechanical shaker and centrifuge at 3500 rpm for 10 min. Floatable liquid were accumulated in distinct draw tubes and cleanse through using 4 g $MgSO_4$ þ 0.5 g PSA and using only 4 g $MgSO_4$. The constituents swirled for 5 min prior to centrifuge. Extracts was purified by using rotary evaporator and proceed for GC-MS analysis.

2.3 Instrumentation

Oxyfluorfen was detected by GC-MS apparatus of Agilent Innovations with auto-injector to 7000 -Tandem mass spectrometer fitted with HP-5 column. GC-MS consist Injector temperature was 280 °C and Oven temperature extending from 70 °C to 280 °C. The working parameters of MS system were- source heat 230 °C; flow current 35 µA; emanation power, –70 eV; repeller power 11 V; ion figure 12 V; extractor –7.2 V; ion center –7.4 V. The existing quadrupole (MS1) and (MS2) in MS system temperature preserved at 150 °C. Helium was operated as hauler gas with current rate of 2.25 mL min^{-1} as bump flow. Nitrogen was operated as bump gas in collision cell with a current rate of 1.15 mL min^{-1} . Other framework were - split ratio 1:10; vacuum (intensive) 2.23×10^{-5} tort; rough space 1.51×10^{-2} torr. Injection capacity was 2 µL.

3. Results and Discussion

The movement of oxyfluorfen herbicide in sandy loam and clay loam soil in the process of continuous flow mode was observed up to 25-30 cm soil depth. The data revealed that in both soils highest amount of oxyfluorfen was detected at 0-5 cm soil height at both applied rate. Sandy loam soil observed the maximum retention of oxyfluorfen residues up to 93.9% in T_1 and 94.8% in T_2 application in 0 to 5 cm soil depth. Similarly clay loam soil found the ultimate retention of oxyfluorfen of 92.1% in T_1 and 96% in T_2 application in 0-5 cm soil height.



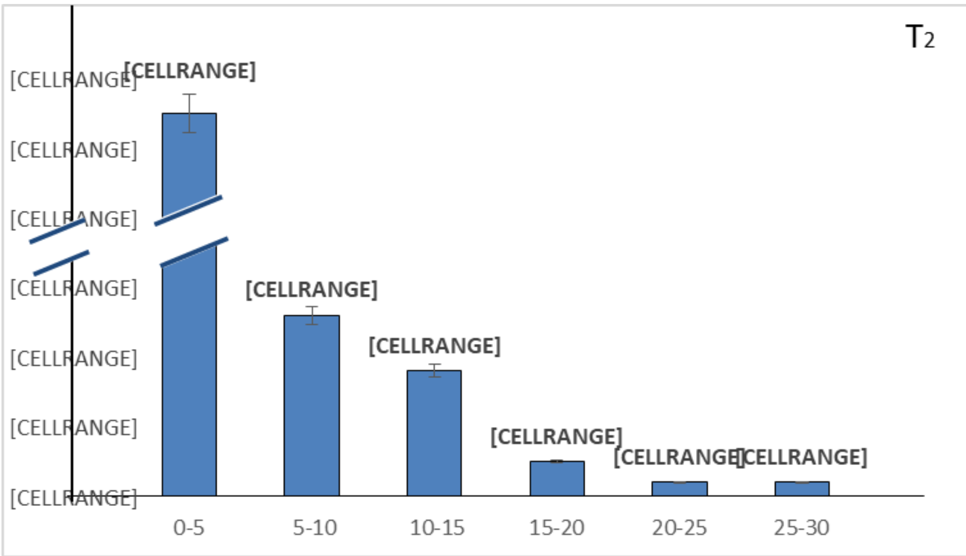
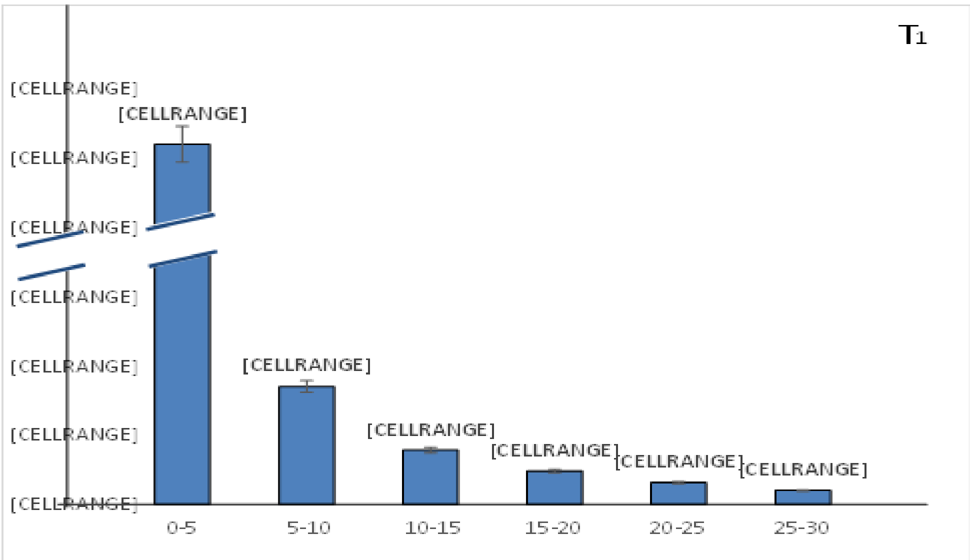


Figure1: Leaching behavior of oxyfluorfen in sandy loam soil in the process of continuous flow conditions. Residues retention (%) in different soil height (cm) at T_1 250 µg and T_2 500 µg of used oxyfluorfen.



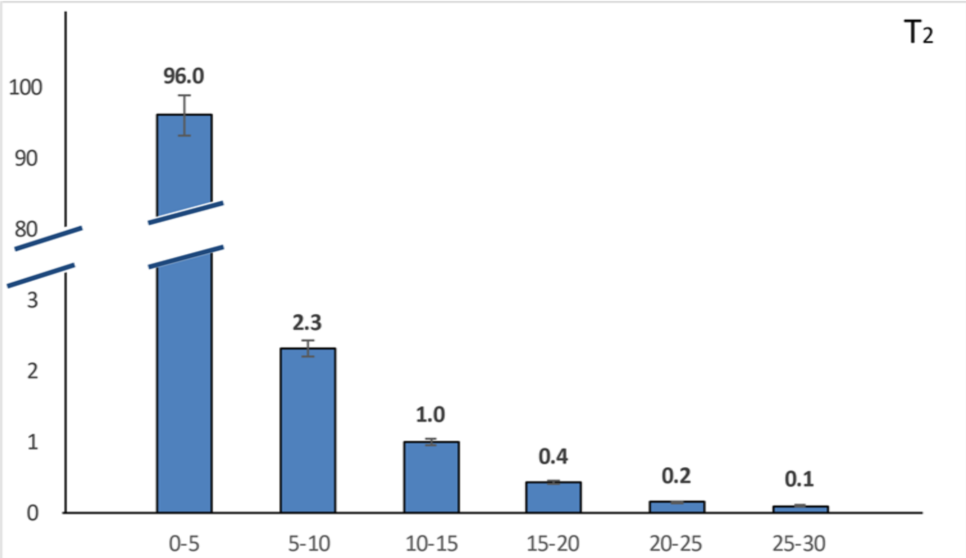


Figure 2: Leaching behavior of oxyfluorfen in clay loam soil in the process of continuous flow mode. Residues retention (%) in different soil height(cm) at T_1 250 µg and T_2 500 µg of used oxyfluorfen.

Results revealed that applied oxyfluorfen herbicide was dispersed in the highest section of the columns in both differently textured soil. The residuum amount in column was found to be supreme in the more elevated soil layer (0-5cm) at both application rates of oxyfluorfen herbicide. The residue level of herbicide started decreasing from 5 to 10 cm soil height that indicating the low potential of oxyfluorfen in soil columns. The concentration of retained oxyfluorfen was found to be higher at top layer (0-10 cm) in clay loam soil in comparison to sandy loam soil due to the higher quantity of active clay particles in clay loam soil. Ramprakash et al. (2017) showed in his experiments that the highest herbicide amount retained at top layer of soil in black soil than red soil. Shobha Sondhia (2008) obtained the maximum amount of oxyfluorfen residues present at 0-10 cm in clay loam soil and oxyfluorfen can leach by high rainfall in soil profile under continuous mode and may have possible to polluted the surface water. Organic carbon content has direct impacts on enhance the leaching potential of herbicides in soil. Arora A. (2017) reported that leaching of oxyfluorfen affected by the presence of organic carbon content in soil. Oxyfluorfen was less mobile in sandy loam soil caused by low organic carbon content 0.30% present in soil. Apart from soil be made up by low carbon composite, oxyfluorfen has the prospects to pollute surface water less than 3m deep (Ying and Williams 2000). On the contrary, Yen et al. (2003) also founded that oxyfluorfen was not moving in soil and do not pollute groundwater less than 3m deep. Devi, K.D. et al. (2015) observed that the fine textured and rich organic matter soil attributed high adsorptive power at top layer of soil and recorded the low residue level corelated to the rough textured soil with low carbon compound. Shishir Tandon (2018) observed the low mobility of oxyfluorfen in clay loam soils, it was not capable to move over 15 cm depth that would prompted substantial ground water contamination. Wauchope et al. (1992) observed herbicide -soil interactions were strong in soils having high organic matter and clay content. Oxyfluorfen has more tendency to organic carbon and less affected to leaching. In this study the soil existed the abundant organic matter with amount of clay and silt indicating the steady mobility of oxyfluorfen in full of moisture environment. The amount of oxyfluorfen herbicide retained is more in clay loam soil as correlated to the sandy loam soil caused by the higher organic carbon content in clay loam soil resulting the more adsorptive capacity of soil constituents for herbicide.

4. Conclusion

Results indicated that the bulk of oxyfluorfen retained at the upper soil horizon indicated the stronger adsorption of herbicide on the soil particles. Beyond 90% oxyfluorfen particles were sustained with in upper 5 cm layer in sandy loam and clay loam soil at the recommended rates of application. The clay loam soil has more adsorptive capacity toward oxyfluorfen herbicide than sandy loam soil. Hence, oxyfluorfen showed poor leaching potential in soil, demonstrate the low risk to ground and surface water contamination.

References

- Arora, A. (2017). Leaching behavior of oxyfluorfen in FYM amended and un-amended sandy clay loam soil.
- Devi, K. D., Abraham, C. T., & Upasana, C. N. (2015). Leaching behaviour of four herbicides in two soils of Kerala. *Indian Journal of Weed Science*, *47*(2), 193-196.
- EFSA Panel on Contaminants in the Food Chain (Contam). (2010). Scientific Opinion on lead in food. *EFSA Journal*, ***8***(4), 1570.

- EPA-738-F02–013. Oxyfluorfen RED Facts. 2002.Available online: https://archive.epa.gov/pesticides/reregistration/web/pdf/ oxyfluorfen_red.pdf (accessed on 26 August 2021)
- Flury, M. (1996). Experimental evidence of transport of pesticides through field soils—a review. *Journal of environmental quality*, *25*(1), 25-45.
- Janaki, P., Sathya Priya, R., & Chinnusamy, C. (2013). Field dissipation of oxyfluorfen in onion and its dynamics in soil under Indian tropical conditions. *Journal of Environmental Science and Health, Part B*, *48*(11), 941-947.
- Rani, N., Duhan, A., & Tomar, D. (2020). Ultimate fate of herbicide tembotrione and its metabolite TCMBA in soil. *Ecotoxicology and Environmental Safety*, *203*, 111023.
- Ram Prakash, T., Yakadri, M., & Leela Rani, P. (2015). Leaching behaviors of oxyfluorfen and oxadiargyl in red and black soils. In *25th Asian-Pacific Weed Science Society Conference on "Weed Science for Sustainable Agriculture, Environment and Biodiversity* (p. 447).
- Rayment GE, Lyons DJ (2011) Australian Laboratory Handbook of Soil and Water Chemical Methods. Inkata Press Private Limited. 38–39.
- Scrano, L., Bufo, S. A., Cataldi, T. R., & Albanis, T. A. (2004). Surface retention and photochemical reactivity of the diphenylether herbicide oxyfluorfen. *Journal of environmental quality*, *33*(2), 605-611.
- Sondhia, S. (2010). Persistence and bioaccumulation of oxyfluorfen residues in onion. *Environmental monitoring and assessment*, *162*(1), 163-168.
- Sondhia, S. (2008). Evaluation of leaching potential of oxyfluorfen in clay soil under field conditions. *Indian Journal of Weed Science*, *40*(1&2), 29-31.
- Sondhia, S. (2009). Leaching behaviour of metsulfuron in two texturally different soils. *Environmental monitoring and assessment*, *154*(1), 111-115.
- Sondhia, S., & Dixit, A. (2007). Determination of terminal residues of oxyfluorfen in onion. *Annals of Plant Protection Sciences*, *15*(1), 232-234.

- Sherrod, L. A., Dunn, G., Peterson, G. A., & Kolberg, R. L. (2002). Inorganic carbon analysis by modified pressure-calcimeter method. *Soil Science Society of America Journal*, *66*(1), 299-305.
- Tudi, M., Daniel Ruan, H., Wang, L., Lyu, J., Sadler, R., Connell, D., ... & Phung, D. T. (2021). Agriculture development, pesticide application and its impact on the environment. *International journal of environmental research and public health*, *18*(3), 1112.
- Tandon, S., Mehra, P., & Sand, N. K. (2016). Leaching behaviour of metsulfuron-methyl.
- Tandon, S. (2018). Leaching potential of oxyfluorfen in soil.
- Tandon, S. (2017). Residue analysis of herbicides in soil, crop and water under different tillage condition in long-term rice-wheat cropping system. *Journal of Food, Agriculture & Environment*, *15*(3/4), 98-101.
- Thakare PD, Patil BM, Kakade SU and Dangore ST. 2002. Studies on chemical weed control in soybean [Glycine max (L.) Merrill]. Crop Research 24: 11-14.
- USEPA. A Review of the Reference Dose and Reference Concentration Processes. U.S. Environmental Protection Agency, Risk Assessment Forum, Washington, DC, EPA/630/P- 02/002F, 2002.
- Wauchope, R. D., Buttler, T. M., Hornsby, A. G., Augustijn-Beckers, P. W. M., & Burt, J. P. (1992). The SCS/ARS/CES pesticide properties database for environmental decision-making. *Reviews of environmental contamination and toxicology: Continuation of residue reviews*, 1-155.
- Ying, G. G., & Williams, B. (2000). Laboratory study on leachability of five herbicides in South Australian soils. *Journal of Environmental Science & Health Part B*, *35*(2), 121-141.
- Yen, J. H., Sheu, W. S., & Wang, Y. S. (2003). Dissipation of the herbicide oxyfluorfen in subtropical soils and its potential to contaminate groundwater. *Ecotoxicology and environmental safety*, *54*(2), 151-156.