DISSIPATION OF BISPYRIBAC-SODIUM IN SOIL, WATER AND SEDIMENT OF FLOODED RICE FIELD

MATTOS M. L. T.; ANDRES A.; ALMEIDA, M. T.; FACIO, M. L.; SILVA, M. F.
Embrapa Temperate Agriculture, Pelotas , RS, Brazil
maria.laura@cpact.embrapa.br

Introduction

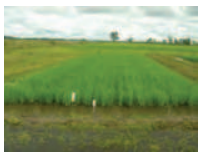
Bispyribac-sodium [sodium 2,6-bis(4,6-dimethoxypyrimidin-2-yloxy)benzoate] is a selective herbicide of the group of pyrimidinebenzoates, employed in commercial formulation for the post-emergent control of weeds in the culture of irrigated rice in the State of Rio Grande do Sul (RS), Brazil. The herbicide is highly toxic and hazardous for the environment, with security interval of 118 days (ANVISA, 2011). It is highly mobile, diffusing easily in the soil, resulting in possible contamination of groundwater and surface water in surrounding areas. Application of this herbicide in flooded rice crops can result in its accumulation in the soil and sediments, from where it can reach irrigation water supplies (BRASIL, 2011). The bispyribac-sodium herbicide is relatively flexible with regards to utilized dosage and application timing. With increasing dosages, control over weeds in more advanced stages of development is achieved. This characteristic has stimulated some producers to abuse the dosage of the product, leading to the risk of contamination of soils and hydraulic systems.

The objective of this work was to evaluate the residence time of bispyribac-sodium in soil, water and sediments, in experimental plots, by determining its dissipation in rice paddy field lowland subtropical.

Material and Methods

The study, with duration of two harvest years, beginning in the harvest period 2008/09, was conducted in the Lowlands Experimental Station (ETB) of Embrapa Temperate Agriculture, in Capão do Leão, RS. The soil of the experimental area, a Typic Albaqualf, presented the following characteristics: clay (13%); pH (4.8); organic matter (1.4%); phosphorous (14.7 mg dm^{-3}); potassium (71 mg dm^{-3}). The treatments comprised (T1) application of 48 g of active ingredient bispyribac-sodium, and (T2) control (without application of bispyribac-sodium). Seeding (cultivar BRS Querência) was performed on 31/10/2009. The bispyribac-sodium was applied post-emergence of weeds on 04/12/2009, by means of coastal sprayer with fan tip. Irrigation of the plots occurred five days after application of the herbicide (09/12/2009), establishing a water film 0,10 m depth. Qualitative and quantitative analyses were conducted in search of residual bispyribac-sodium from samples of soil, water and sediment, during the 2009/10 harvest season. Five composite soil samples from the plots were collected, at depths of 0-20 and 20-40 cm, 500 g in mass each, 1 day before application of the herbicide (1DBA) and after application, 1DAA, 3DAA and 210DAA. After irrigation, water samples (1,0 L each) and sediment samples were collected, in triplicate, at depth of 0-20 cm, 1 day after irrigation (1DAI), 3DAI, 7DAI, 10DAI, 15DAI, 20 DAI, 30 DAI, 60 DAI and 90DAI. During the period of drainage of the plots (90DAI), at the outlet of the piping, samples of water were collected at variable intervals, at 30, 60 and 90 minutes after start of drainage. In this period, water samples from the main and the secondary drainage canals were also collected. Chromatographic analyses were conducted at the Laboratory Bioassay Analysis and Environmental Consultancy Ltda., in Porto Alegre, RS, in a high performance liquid chromatograph (HPLC) coupled to a mass spectrometer (LC-MS/MS), model Applied Biosystems 3200 Qtrap. The detection limits for bispyribac-sodium were 0,1 µg L^{-1} and 0,01 µg L^{-1} for soil/sediment and water, respectively.

Area of Experirments Pesticide Dissipation



Experimental parcel 120 m^2

Results and Discussion

The residual concentration of bispyribac-sodium in the soil at 300DAA during harvest 2008/09 was 2.3 µg L^{-1}, confirming the characteristic persistence of this molecule in the soil (BRASIL, 2011). The concentration values of the herbicide detected in the soil at 1DAA, 3DAA and 210DAA, at 0-20 cm depth, were 176.6, 129.4 and 30.5 µg L^{-1}, respectively (Figure 1). The results demonstrate that the herbicide is resistant to degradation, remaining in the soil long after its application. This fact can lead to phytotoxicity of sensitive cultures seeded in succession. The residual concentrations of bispyribac-sodium in the sediment and the water from the irrigated rice field water film presented a negative linear regression tendency ($y_{sediment}$ = -14.68x + 169.0 R^2 = 0.708; y_{water} = -0.476x + 5.905 R^2 = 0.911) during the 90 day period of herbicide dissipation (Figure 1).
Residual amounts of bispyribac-sodium declined consistently over time in the water and the sediment, with concentrations above the detection limit up to 60DAA and 90DAA, respectively. The degradation of the herbicide in water at 90DAA was 99.72%, and in the sediment 97.1%, relative to the concentration at 1DAA. In view of the moderate persistence and mobility of the herbicide in many soils, and the nature of irrigated rice crops involving water and drainage canals, flooded areas associated with the crops become vulnerable to the dissipation of sprays and superficial migration (EPA, 2011). The residual concentrations up to 30DAA remained above maximum allowable limits in potable water for each active ingredient, applied in the European Union, which should not exceed 0.1 µg L^{-1} (Directive 98/83/CE DU CONSEIL, 1998). The concentrations of the herbicide in water during the drainage period and in the waters of the main and the secondary drainage canals of the experimental area were < 0.01 µg L^{-1}. It should be noted, however, that trace concentrations can be an indicative of warning impelling the adoption of Integrated Pest Control (MIP) in irrigated rice crops in RS.

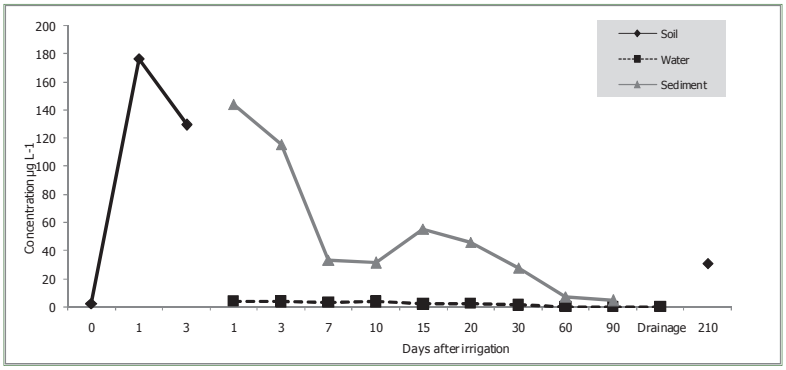


Figure 1: Bispyribac-sodium concentration over time in soil, water and sediment.

Conclusion

The herbicide bispyribac-sodium remained cumulatively in Typic Albaqualf after successive application during two years of irrigated rice culture. Residual amounts were dissipated in irrigation water by 99.72% and in the sediment by 97,1% over 90 days after application. Waters that make up the rice irrigation water film should not be sent to hydraulic systems for a period of 30 days post-application of the herbicide.

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