

MODELLING OF INSECTICIDE CHLORPYRIFOS OCCURANCE IN NATURAL WATER BODIES AT MARASSANA AREA

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Introduction

Pesticides are transported from the field to the surface water mainly by the process of runoff and leaching through soil in to ground and surface waters. Variation of pesticide concentration in surface and ground waters with respect to different parameters like rainfall, transport, quantities applied etc, have been established by authors using multiple regression analysis (MRA) (Kreuger and Törnqvist, 2008). MRA is used to determine simultaneous effect of several independent variables on a dependent variable. In this study MRA is used to show the effect of chlorpyrifos (CP) application in the catchments and precipitation in the area, on CP contamination in ground waters and surface waters at Marassana area. Data collected in (Menike et al., 2009) is used for analysis. The specific objectives of this analysis were to explore the dependence of CP concentration in surface water and ground water at Marassana area on precipitation and CP use. Hence an empirical equation is to be established that describes the relationship.

Materials and Methods

The site selection, sampling and the analysis procedure are described in detail in Menike et al (2009). In their study water sampling was carried out at two community wells (W1 and W2)

situated in the area of study and at two locations (L1 and L2) along the Kiwullinda Oya stream. Water samples were collected once every three days during the vegetable cultivation period from 1st May to 15th August 2009. Rainfall data and the CP application data were also collected during the same period.

Regression Modelling

Pesticides are transported from the field to the surface water mainly by the process of runoff and in to ground water sources by leaching through soil. Although numerous factors affect pesticide concentrations in ground and surface water bodies, many of these factors such as soil type, stream channel network, land use, and landscape remain almost unchanged over time and for a given geographical system. In such cases, changes of pesticide concentrations in surface and ground water are primarily dependent on two major environmental variables; rainfall and pesticide application in the catchments. Rainfall determines the total amount of runoff water, and pesticide use represents the source of contamination. The basic form of the regression equation was proposed based on the above conditions.

Regression equation

$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + U_i$$

Y denotes the CP load ($\mu\text{g/l}$) of water in the stream at two location or two

wells and X_1 and X_2 stand for cumulative rainfall (mm) and the cumulative CP (40%) application quantity (l) to the catchments during period between two consecutive sampling of three days span. $\beta_0, \beta_1, \beta_2$ and β_3 are slope coefficients of each variable. X_3 is a dummy variable, which compares the CP concentrations of two locations L_1 and L_2 or two wells W_1 and W_2 (estimate the shift effect). U_i stand for unexplained variations of the model.

Results and discussion

MRA of Variation of CP Concentration of Two Locations (L_1 and L_2) Along the Stream

The collected raw data were subjected to MRA. The analysis results of CP concentration of stream water, indicates that the model is significant; therefore regression model is accepted. The fitted model for CP concentration variation (Y) along the stream with rainfall (X_1) and CP application (X_2) to site is given below.

$$\hat{Y} = 0.227^* + 0.021^* X_1 + 0.05 X_2 + 0.112 X_3$$

[2.949]
[8.629]
[0.074]
[0.267]

Where * denotes 1% level of significance
t- statistics values are given within the brackets

Adjusted $R^2 = 0.51$ for sample size of 78, given that 51% of the variability in the concentration level (Y) is explained by the model (rainfall, CP application and the location). The three-day cumulative rainfall (X_1) shows effect on stream water CP concentration level (Y). According to the model, coefficient of X_1 is 0.021. This indicates that, a 1 mm of three day cumulative rainfall received in to the catchments cause to increase the CP concentration at the stream water

by 0.021 $\mu\text{g/l}$. The CP (40%) application to the site (X_2) has no effect on CP concentration of stream (Y). Accordingly CP application doesn't show direct statistical relation with CP concentration of stream as above. But rainfall shows an effect on CP concentration of the stream, meaning that rainfall washing off the CP remaining in the catchments. Since the catchment's receives CP with CP application, it is hard to explain above-mentioned two conditions. The half-life of the CP is more than 30 days in soil. Therefore catchments may be saturated with CP due to the long term unlimited application by the farmers. At the rainfall event, existing CP is desorbed from soils and washed off from plants, causing an increase in the CP concentration of the stream.

According to the coefficient of dummy variable X_3 , there is no statistically significant difference between the CP concentrations of two locations (L_1 and L_2).

MRA of Variation of CP Concentration of Two Community Wells

The analysis results of CP concentration of well water indicates that the model is significant; therefore regression model is accepted. The fitted model for CP concentration variation of two community wells with rainfall and CP application to site is given below.

$$\hat{Y} = -0.058 + 0.003 X_1 + 0.65 X_2 + 0.136 X_3$$

[-0.324]
[0.75]
[5.84]
[0.714]

Adjusted $R^2 = 0.33$ for sample size of 76, indicated that 33% of the variability in the concentration level (Y) is explained by the model (CP application, rainfall and the location).

As the regression results, three-day cumulative CP (40%) application (X_2) is significant at 5% and 1%. Coefficient of X_2 is 0.65. This indicates, the application of 1000 ml of CP (40%) to the catchments during previous three days causes an increase of CP concentration in well of 0.65 $\mu\text{g/l}$.

Three day cumulative rainfall has no effect on the CP concentration of community well water (Y).

According to the coefficient of dummy variable there is no statistically significant difference between the CP concentrations of two wells.

Conclusion

Stream water- A 1 mm of cumulative rainfall received in to the catchments during previous three days caused an increase in the chlorpyrifos concentration at the stream water of 0.021 $\mu\text{g/l}$.

The CP application amount to the site has no effect on CP concentration on the stream.

There is no statistically significant difference between the CP concentrations of locations (L_1 and L_2)

Well water - Application of 1000 ml of CP (40%) to the catchments of both the wells during previous three days would cause an increase of CP concentration in the wells of 0.65 $\mu\text{g/l}$.

There is no statistically significant difference between the CP concentrations of two wells.

Three day cumulative rain fall has no effect on the CP concentration of community well water.

The results of the MRA presented in the two selected locations (i.e; wells and stream) demonstrated that, precipitation and application rates are the two major factors controlling the

dynamics of CP transport into surface and ground water bodies.

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References

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