Current-use insecticides, phosphates and suspended solids in the Lourens River, Western Cape, during the first rainfall event of the wet season

Ralf Schulz[1]*, Sue KC Peall[2], James M Dabrowski[1] and Adriaan J Reinecke[1]
[1] *Department of Zoology, University of Stellenbosch, Matieland 7602, South Africa*
[2] *Forensic Chemistry Laboratory, Department of Health, Cape Town 8000, South Africa*

Abstract

Pesticide contamination resulting from agricultural runoff depends on the time period between application and rainfall. In Western Cape orchard areas, the last pesticide application of the growing season in summer takes place at the end of February. Pesticides, total phosphates and total suspended solids (TSS) were measured in the Lourens River at the beginning of April 1999 prior to the first rainfall of the rainy season and in the middle of April during high discharge following the first rainfall of 9.6 mm/d. Pre-runoff samples indicated only contamination with total endosulfan (α, β, sulphate) at levels up to 0.06 µg/l. Runoff during the first rainfall event resulted in an increase in the levels of endosulfan, chlorpyrifos and azinphos-methyl, to 0.16, <0.01 and 0.38 µg/l, respectively, in water samples and 245, 344, and 244 µg/kg in suspended sediments. In terms of chemical load the single rainfall event caused a loss of 15.1 g/h endosulfan, 1.8 g/h chlorpyrifos and 20.5 g/h azinphos-methyl. The second rainfall event caused no measurable increase in pesticide levels, although the amount of rain was even higher (14.4 mm/d). Levels of both total phosphate and TSS were also increased during the first runoff event. Transient contamination levels exceeded the target water quality range proposed by the South African Department of Water Affairs and Forestry (DWAF). The Lourens River site downstream of the farming area is identified as a site where potentially toxic conditions might arise.

Introduction

Runoff is regarded as an important route of entry of non-point source pollutants in surface waters in agricultural areas (Cooper, 1993). Runoff occurs during the rainy season, which lasts from April to December in the Western Cape. Runoff-related input usually leads to an increase of water level, nutrients and total suspended solids (TSS); pesticides may enter the surface water as either water-dissolved or particle-associated chemicals (Wauchope, 1978).

Pesticide quantities that enter surface waters via runoff are dependent on a number of factors, including the time interval between the application of pesticides and the first heavy rainfall event, the slope and soil types of the catchment, the pesticide application, and the size and characteristics of buffer strips (Wauchope, 1978). Thus, in the context of the Western Cape, a very important period with regard to determining runoff-related contamination is in April, when the first heavy rains normally fall after the end of the spraying season in late February.

Only a few studies deal with pesticide levels in aquatic systems in South Africa: farm dams (Davies and Peall, 1997; Hassett et al., 1987), lakes (Greichus et al., 1977) or river ecosystems (Grobler, 1994; Roux et al., 1994). None of these studies has attempted to establish a direct link between chemicals currently used in agriculture and contamination of the aquatic environment. Moreover, they have not addressed the problem of runoff as a potential route of entry into freshwater ecosystems. A factor that has contributed to the lack of research is the shortage of laboratories with the equipment and expertise to carry out complex analyses (Dallas and Day, 1993). The transient nature of pesticide peak levels in streams (Kreuger, 1995; Schulz et al., 1998) adds a further problem to the monitoring of pollution, since the sampling programme must be well-adapted to cover the short periods with peak contamination. During recent decades a deterioration in water quality in Western Cape rivers has been observed. This shift has also occurred in the middle and lower reaches of the Lourens River, and is attributed to intensified agriculture, erosion problems and loss of indigenous vegetation (Tharme et al., 1997). No information is available about the extent to which toxic substances are responsible for the degradation of the Lourens River.

The aim of this study was to determine the extent to which pesticides, phosphates and suspended solids from the surrounding orchard areas contaminated a typical Western Cape stream. Runoff-related input following the first rainfall events of the wet season was investigated. Pesticide concentrations were compared to standard toxicity values, to determine whether there might be any potential threat to the aquatic communities in the Lourens River.

Materials and methods

Study area

The Lourens River rises at an altitude of 1080 m in a naturally vegetated fynbos area and flows in a southwesterly direction for 20 km before discharging into False Bay at The Strand (S34°06´; E18°48´). The catchment region is characterised by intensive farming, with orchards and vineyards in its middle reaches. The Lourens River has a total catchment area of 92 km^2 and receives an annual mean rainfall of 915 mm. Roughly 87% of its 35x10^6 m^3 mean annual discharge occurs during the autumn, winter and early

* To whom all correspondence should be addressed.
Present address: Zoological Institute, Technical University, Fasanenstrasse 3, D-38092 Braunschweig, Germany,
☎+49 531 391 3184; fax +49 531 391 8201; e-mail: R.Schulz@tu-bs.de
Received 19 June 2000; accepted in revised form 6 November 2000.