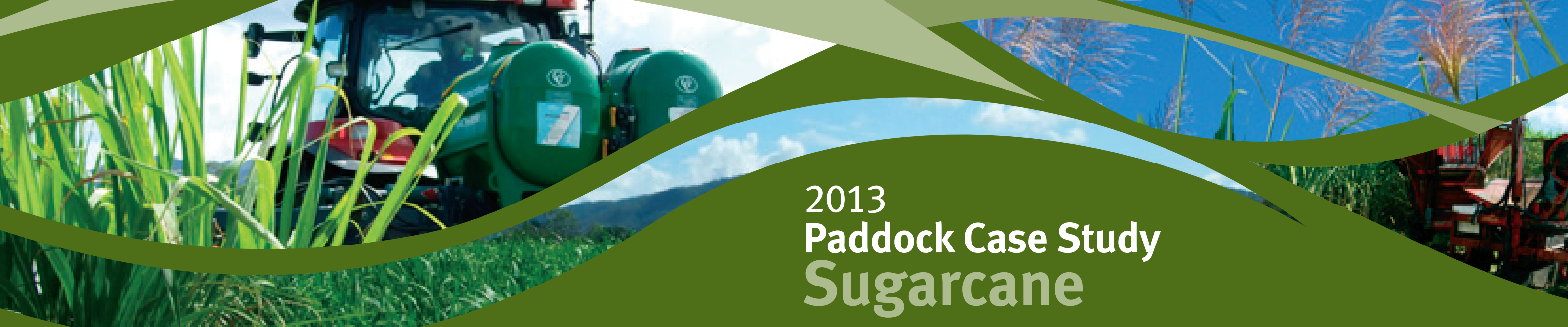


2013
Paddock Case Study
Sugarcane
Reef Water Quality Protection Plan

Modelling pesticide runoff from improved land management scenarios

Background

The Reef Water Quality Protection Plan (Reef Plan), a joint initiative of the Australian and Queensland Governments, focuses on the threat posed by diffuse source agricultural pollution. It is designed to reduce the amount of pollutants flowing into waterways and the Great Barrier Reef in order to build the resilience of the reef to impacts of other stressors.

The Paddock to Reef Integrated Monitoring, Modelling and Reporting (Paddock to Reef) Program measures and reports on progress towards Reef Plan and Reef Rescue goals and targets. Funded jointly by the Australian and Queensland Governments, it is a collaboration involving governments, industry bodies, regional natural resource management bodies, landholders and research organisations.

Paddock monitoring and modelling are important components of the program. This work is funded by the Australian Government's Reef Rescue initiative with significant support from the Queensland Government. The program conducts paddock trials in various regions in partnership with other organisations to assess the water quality benefits of different land management practices.

Key findings

- Simulations showed a shift away from reliance on residual herbicides towards greater usage of knockdown products will lead to an improvement in runoff water quality. This is particularly true when the lower toxicity of the knockdown products is taken into account (ANZECC/ARMCANZ 2000).
- There is a need for information on the environmental persistence and toxicity of alternative residual herbicides such as s-metolachlor and pendimethalin before a full assessment of the benefits and disadvantages of their increased use can be made.
- Management of herbicides must always take into account effective, integrated weed management so as to avoid a weed outbreak and the need for further herbicide use.

About this case study

Paddock scale models are important tools in assessing land management practice effects on the water quality of runoff from farms. The HowLeaky crop and water balance model has been updated to include a pesticide dissipation and transport model which predicts the runoff loss of pesticides from a paddock.

Under best management practice guidelines, reduced reliance on the use of 'residual' herbicides in favour of 'knockdown' herbicides is considered an improved farming practice. Residual herbicides are applied pre-emergence to prevent seeds germinating and/or emerging and, as such, are required to persist for a period of time after application. Knockdown herbicides are used to kill emerged weeds and therefore generally have shorter half-lives in soil than residual herbicides. Commonly applied residual herbicides are the photosystem II (PSII) inhibiting compounds which are frequently detected in Great Barrier Reef waterways and in the Great Barrier Reef lagoon: atrazine, diuron, hexazinone and ametryn (Lewis et al., 2009, Shaw et al., 2010).

Methods

Using the pesticides model in HowLeaky, a comparison was made of the potential offsite losses of a range of herbicide products: PSII residuals (atrazine and diuron), knockdowns (2,4-D and glyphosate) and emerging (newly developed) herbicides (s-metolachlor, isoxaflutole and pendimethalin).

Herbicides were applied according to best pesticide (B class) management for cane in the Mackay Whitsunday region, involving limited use of residuals in both plant and ratoon cane, with weed control achieved through increased use of knockdown herbicides. In this scenario, the 'emerging' herbicide s-metolachlor replaced an application of traditional residual herbicides in the plant cane. The herbicide management practices were modelled on a legume fallow followed by plant cane and four ratoons under zero tillage with green cane trash blanketing (Shaw et al. 2011).

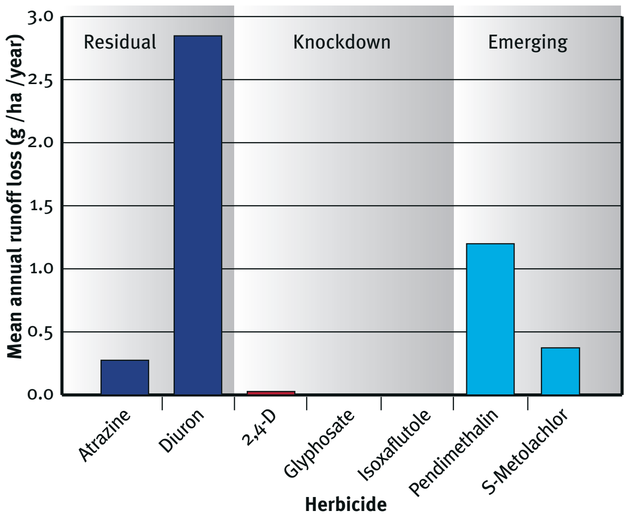
Results

The bar graph below shows annual average annual runoff loads (grams/hectare/year) for residual, knockdown and emerging herbicides. In this scenario, all pesticides were applied on the same days at label rates with only one application per year on the same day. This application scenario is unrealistic; however, it provides a direct comparison of the effect of the herbicides on loss in runoff.

Concentrations in runoff of the knockdown products were notably lower than for the residual herbicides. For example, the average daily 2,4-D concentrations were more than 100 times lower than for diuron. Similarly, runoff concentrations of the emerging herbicide isoxaflutole were more than 500 times lower than for diuron and atrazine.

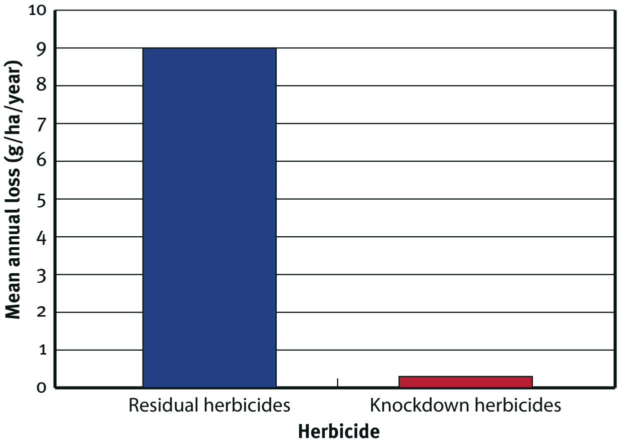
Applications of s-metolachlor and pendimethalin resulted in average runoff concentrations higher than for atrazine, but still lower than for diuron. S-metolachlor and pendimethalin are both relatively toxic to aquatic plants and other aquatic organisms, although they are not classed as PSII inhibiting herbicides.

Simulated mean annual runoff loss for residual, knockdown and emerging herbicide products with only one application per year on the same day



The following bar graph shows annual runoff losses for a more realistic application scenario for best management practice (B) on cane in the Mackay Whitsunday region. Under this scenario, the total amount of knockdown herbicides (glyphosate and 2,4-D) lost is still significantly lower than the amount of the residual herbicides (atrazine and diuron).

Simulated annual mean runoff loss for residual and knockdown herbicide products



Differences in the relative mean annual losses of herbicides observed between scenario one and scenario two reflect the number of applications simulated for individual products and the timing of those applications relative to rainfall events. These results are supported by the *Comparing runoff loss of knockdown and residual herbicides in the Herbert catchment and the Comparing residual versus knockdown herbicides in sugarcane in Mackay* case studies.

This study represents a simplified investigation of this issue; however, it demonstrates the utility of the HowLeaky simulation model.

Authors

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References

ANZECC and ARMCANZ (2000). Australian and New Zealand guidelines for fresh and marine water quality. Volume 1 – the guidelines. National water quality management strategy paper No 4. Australian and New Zealand Environment and Conservation Council and Agriculture and Resource Management Council of Australia and New Zealand, Canberra, Australia.

Lewis S, Brodie J, Bainbridge Z, Rohde K, Davis A, Masters B, Maughan M, Devlin M, Mueller J, Schaffelke B (2009). Herbicides: a new threat to the Great Barrier Reef. Environmental Pollution 157, 2470–2484.

Shaw M, Furnas M, Fabricius K, Haynes D, Carter S, Eaglesham G, Mueller JF (2010). Monitoring pesticides on the Great Barrier Reef. Marine Pollution Bulletin 60, 113-122.

Shaw M, Silburn DM, Thornton C, Robinson B, McClymont D (2011). Modelling pesticide runoff from paddocks in the Great Barrier Reef with HowLeaky. MODSIM 2011, Perth WA.

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