PHOSPHORUS LOSSES BY SURFACE RUNOFF IN TWO RICE ROTATION SYSTEMS

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BACKGROUND

Sustainability of water quality and quantity in Merín Lagoon (ML) basin has become an issue of concern. Phosphorus (P) loads from agricultural environment has recognized as one of the major sources influencing water impairment (Ministerio de Ambiente, 2021).

The main area of rice cultivation in Uruguay (70% of the total) is located in this watershed, where most rice is rotated with pastures of varied duration. Though, in recent years a trend towards intensification has been observed, through the increase in the frequency of rice in the rotation (DIEA, 2018).

P runoff can be affected by rate of fertilizer added, soil nutrient status and management practices, which differ with different rice rotation systems. However, there is a knowledge gap on quantifying P losses in the water from rice paddies as well as the influence of the intensification of rice-pasture rotations on P transport via surface runoff from flooded fields.

OBJECTIVES

- Quantify P losses via surface runoff from two rice rotations.
- Evaluate the effect of intensification of crop-pasture systems on surface runoff and P losses.

METHODS

The study was conducted in a long-term experiment initiated in 2012 in Treinta y Tres, Uruguay (33º16′23´´ S, 54º10′24´´ W) at the National Institute of Agricultural Research (INIA), "Paso de la Laguna" Research Unit (Fig. 1).

Figure 1. Experimental plot of 20 m wide x 60 m long at "Paso de la Laguna" Research Unit.

We assessed two contrasting rice-based rotation systems: (a) rice-pasture rotation (RP, rice-cover crop-rice followed by 3.5 yr of a perennial pasture, and (b) continuous rice (RR, annual rotation of rice-cover crop). A complete randomized design with two treatments, each replicated twice in field plots (1200 m^2), was used. The experiment was carried out during the flooded period of the 2020-2021 crop season, from November 26 to March 30 (125 days). The water balance method was implemented to determine the surface runoff (Xu et. At, 2020).

Soil properties determined before rice dry seeding are shown in Table 1. The total N, P_2O_5 and K_2O application rates were 76, 15 and 80 kg ha^{-1} and 144, 85 and 45 kg ha^{-1} for RP and RR, respectively.

Table 1. Soil chemical properties in two rice-based systems.

	pH (H2O)	N (%)	C.Org (%)	P citric acid (mg kg^{-1})	K (meq 100g^{-1})	PMN (mg kg^{-1})	P citric acid (mg kg^{-1})
	0 – 15 cm						0 – 2,5 cm
Rice-pasture	5.7 ± 0.03	0.18 ± 0.02	1.7 ± 0.20	13.6 ± 0.4	0.17 ± 0.02	23.7 ± 4.7	46.0 ± 7,0
Continuous rice	6.2 ± 0.52	0.15 ± 0.03	1.4 ± 0.27	6.0 ± 0.4	0.14 ± 0.01	15.3 ± 1.5	7.0 ± 2,5

* Potential mineralizable nitrogen

RESULTS

Although both treatments required a rather similar amount of irrigation volume (752 ± 96 mm), the surface runoff for RR (237 ± 6 mm) was a little higher than for RP (205 ± 14 mm). The total precipitation during the monitoring period was 618 mm.

The average total phosphorus (TP) concentration of the inflow water (coming from Olimar River) was 0.15 ± 0.06 mg L^{-1}. TP contents of standing water in the paddy field peaked in the first six days of paddy flooding (Fig. 2). Then, the P concentrations were slowly going down and stabilizing in the paddy field water over time. The mean concentrations were always higher for RR (0.35 – 6.50 mg TP L^{-1}) than for RP (0.19 – 2.99 mg TP L^{-1}) throughout the measurement period.

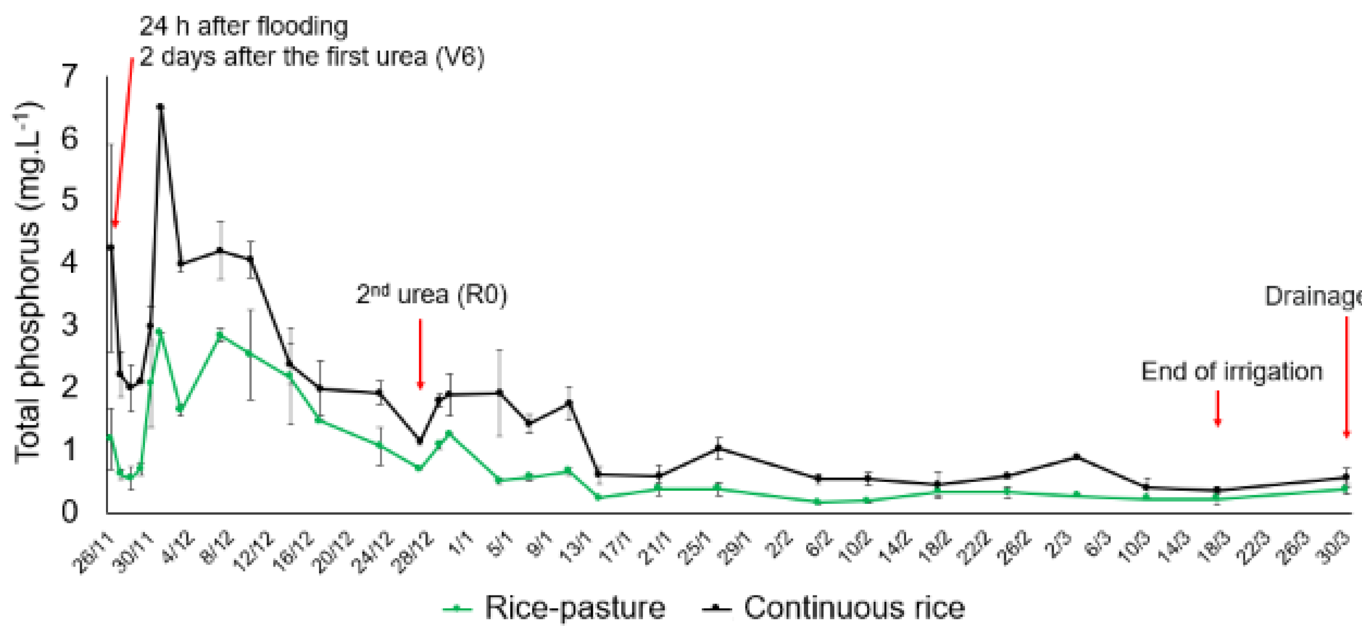

Figure 2. Variation on P concentration in the flooded water in two rice rotations .

There were an average of 17 surface runoff times. The variations in the TP losses were relatively consistent with the surface runoff volume. A single event (pre-harvest drainage) accounted for 41 and 55% of the total export of TP for RR and RP, respectively, due to high outflow volume (Fig 3).

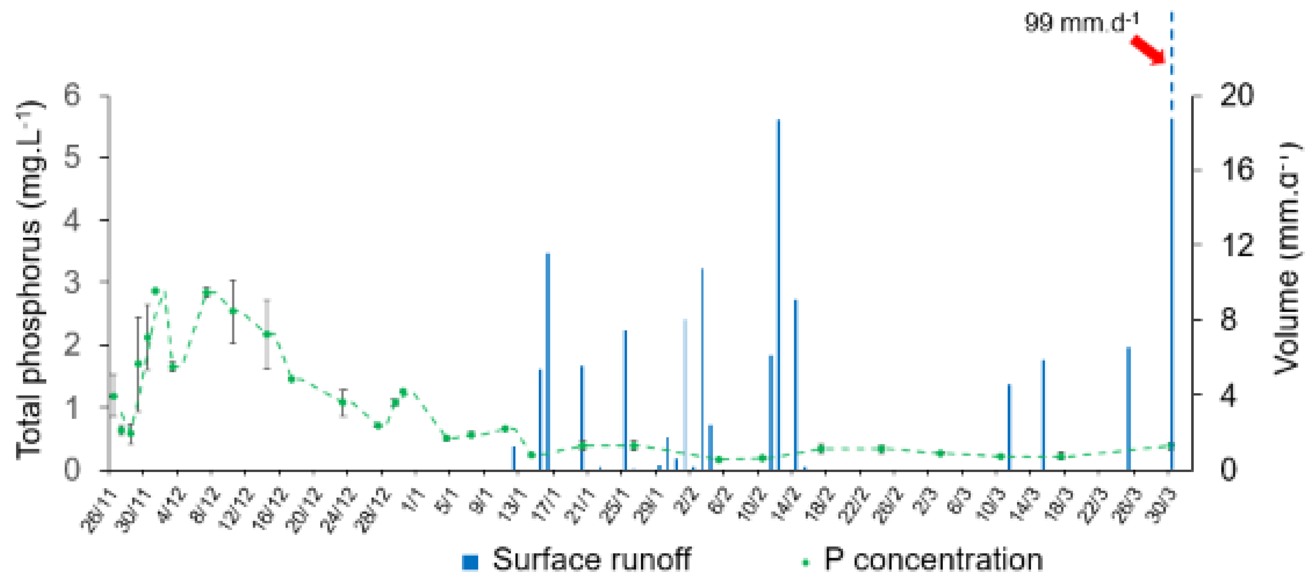

Figure 3. Surface runoff in rice-pasture rotation.

The results of this study caution against the intensification of rice-pasture systems due to higher TP losses through surface runoff (Fig. 4). The intensified rotation (RR) increased TP losses by 2.3 times compared with RP (1.4 and 0.6 kg TP ha^{-1}, respectively).

Figure 4. Export loads of total P in two rice-based systems.

CONCLUSIONS

This study analyzed P losses via surface runoff in one rice growing season, although preliminary data alert about the potential risk of conversion of rice-pasture rotation to more intensive rice production systems. Avoiding surface runoff at the beginning of the flood period (due to the high P concentrations in water) and at the pre-harvest drainage (due to the high potential outflow volumes), are the two key moments to take in consideration to reduce P losses during the flooded rice period.

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