Loss of sediments and nutrients through runoff steepness and soybean variety on portuguesa river basin

Perda de sedimentos e nutrientes através de inclinação de escoamento e variedade de soja na bacia hidrográfica portuguesa

Manoel Moisés F. de Queiroz; Ana Luca de A. dos Santos**; Simone D. Gomes***

Abstract - There is a great concern in areas with intensive agricultural use, such as physical structure of soil, management system, pesticides application schedule and others. Those practices are associated with environmental problems that indirectly affect the life quality as runoff and other nutrients that are carried through it. This trial studied the loss of sediments, phosphorus and total nitrogen through runoff during the cycle of soybean crop, 2007/2008, in a tillage area on Portuguesa river basin, Paraná state, Paraná. The experimental design had sixteen plots with four treatments and four replications, two steepness and a green cover. The treatments were represented by T1 (conventional soybean steepness < 10 %); T2 (transgenic soybean steepness < 10 %); T3 (conventional soybean steepness > 10 %) and T4 (transgenic soybean steepness > 10 %). During the trial installation, the authors respected the steepness direction. There were eight occurrences of rainfall during the crop cycle. But, the runoff occurred only during the four first ones. The results showed that concentrations varied a lot because of the variability of drained volumes. The behavior of total nitrogen as a parameter got a good correlation with the drained volume. The parameter phosphorus obtained several concentrations despite the drained volume. Volatile solids concentrations were higher than the fixed solids ones. There was no significant effect ($p \leq 0.05$) of green cover concerning the obtained results, as well as steepness.

Key words loss of nitrogen, loss of phosphorus, transgenic soybean

Resumo - Há uma grande preocupação em áreas com uso agrícola intensivo, tais como a estrutura física do solo, sistema de gestão, programação de aplicação de pesticidas e outros. Essas práticas estão associadas a problemas ambientais que afetam indiretamente a qualidade de vida como o escoamento e outros nutrientes que são realizadas através dele. Este ensaio estudou a perda de sedimentos, fósforo e nitrogênio total através de escoamento durante o ciclo da cultura da soja, 2007/2008, em uma área de lavoura em bacia do rio Portuguesa, Estado do Paraná, Paraná. O delineamento experimental teve dezesseis parcelas com quatro tratamentos e quatro repetições, duas declividade e uma cobertura verde. Os tratamentos foram representados por T1 (inclinação de soja convencional, <10%), T2 (inclinação de soja transgénica <10%) e T3 (inclinação de soja convencional,> 10%) e T4 (inclinação de soja transgénica> 10%). Durante a instalação do julgamento, os autores respeitada a direção declividade. Havia oito ocorrências de chuvas durante o ciclo da cultura. Mas, o segundo turno só ocorreu durante os quatro primeiros. Os resultados mostraram que as concentrações variaram muito por causa da variabilidade dos volumes drenados. O comportamento do nitrogênio total como parâmetro tem uma boa correlação com o volume drenado. O fósforo parâmetro obtido várias concentrações apesar do volume escoado. Concentração de sólidos voláteis foram maiores do que os sólidos fixos. Não houve efeito significativo ($p \leq 0,05$) da cobertura verde sobre os resultados obtidos, bem como declividade.

palavras-chave perda de azoto, a perda de fósforo, de soja transgénica

Recebido em 01 09 2012 Aceito em 28 03 2012
* Universidade Federal de Campina Grande, Campus Pombal-PB, Rua Jairo Vieira Feitosa, s/n, Bairro dos Pereiros,58.840-000, Pombal-PB,BR. E-mail - moises@ccta.ufcg.edu.br
**Universidade Estadual do Oeste do Paraná, Rua Universitaria, 2069, Jardim Universitário, 85.819-110, Cascavel-PR, BR. E-mail ana.almeida@integrada.coop.br, simoned@unioeste.br.

INTRODUCTION

Agricultural nonpoint source pollution (diffuse pollution) has been a great concern on water resources and may be major contributing factors to surface water eutrophication (Sharpley et al.,2003). For examples, Boesch et al. (2000) reported that agriculture was the largest source of both nitrogen and phosphorus entering the Chesapeake Bay, USA; Tabuchi (2005) reported that eutrophication in Lake Kasumigaura, Japan was caused by point and nonpoint source pollution and that agriculture was one of major nutrient sources. Agriculturally driven eutrophication would results in unprecedented ecosystem simplification, loss of ecosystem services, and species extinctions (Carpenter et al., 1998; Tilman et al., 2001). Thus, reductions in nutrient transport from agricultural watersheds were necessary to prevent eutrophication. The use of agrochemicals such as pesticides and fertilizers constitutes an important aspect of modern agriculture, as they are needed to control various pests and improve soil fertility. The benefits are increased supplies of food, but problems arise when significant amounts of agrochemicals accumulate as residues in soils or migrate into our drinking water supplies (Robinson et al. 2007).

Among the various agricultural activities, intensive use of agrochemicals can have a serious impact on water resources because nutrients may seep out resulting in increases in nitrogen and phosphorus in water bodies. Thus, an understanding of the runoff characteristics of nutrients from watersheds with intensive agricultural production is needed to plan appropriate mitigation. The West and Southwest regions of Paraná state appear as regions where the agricultural activities are quite intense, and the problems arising from these activities. These agricultural activities emphasize the cultivation of corn, soybeans, wheat and oats.

The objective this work was to study the loss of sediments, phosphorus and total nitrogen through runoff during the cycle of soybean crop, 2007/2008, in a tillage area on Portuguesa river basin, Paraná state, Brazil.

MATERIALS AND METHODS

This study was carried out in a farm located in Portuguesa River watershed (location, latitudes 24º36'11"S and 24º31'39"S and longitudes 53º7'50"W and 52º59'8"W) in Ubiratã city, Northwest of Paraná state. The predominant agricultural activity is the cultures of soy, and wheat and corn. The handling practice used in the rural property is the System Direct Planting, used three years ago. There were occurrences of rainfall during the crop cycle of summer (2007/2008). During the experiment there were eight rainfalls. However, the runoff was formed in the first four rainfall events.

The area was planted with transgenic and conventional soybeans considering two slopes, <10% and >10%. It is noteworthy respect to the situation of cultivation employed by the owner, i.e., the experiment was carried out in accordance with the timetable of the owner and there was no interference in the system of crop management of conventional and transgenic soybeans, grown by local farmer. After planting, the plots are demarcated; the gutters were installed, according to the two slopes (towards the ground) and vegetation cover.

For the experimental design, 16 plots with 2,0 m^2 were demarcated using for each plot to collect runoff (natural rainfall) a metal box with 2,0 m long and 1,0 m wide, with a collection pipe in one of ends, connected to a storage container with 20 liters (Figure 1). The sixteen plots were constrained in the direction of slope in four treatments. Thus the experimental design had sixteen plots with four treatments and four replications, two steepness and two green cover. The treatments were represented by T1 (conventional soybean steepness < 10 %); T2 (transgenic soybean steepness < 10 %); T3 (conventional soybean steepness > 10 %) and T4 (transgenic soybean steepness > 10 %).

In the plots were collected volumes of surface runoffs throughout the crop cycle after the occurrence of precipitation. The drained volume surface runoffs were collected in plastic container in which they have been adequately quantified, identified and stored under refrigeration.

In the samples of surface runoff we determined the concentrations and amounts of total nitrogen (N),

phosphorus (P), total solids (TS), volatile solids (VS) and fixed solids (FS) using Standard Methods procedures (1995).

.

RESULTS AND DISCUSSION

The results of load of N, P and TS in surface runoff obtained in this experiment are showed in the Figures 2, 3 and 4 respectively.

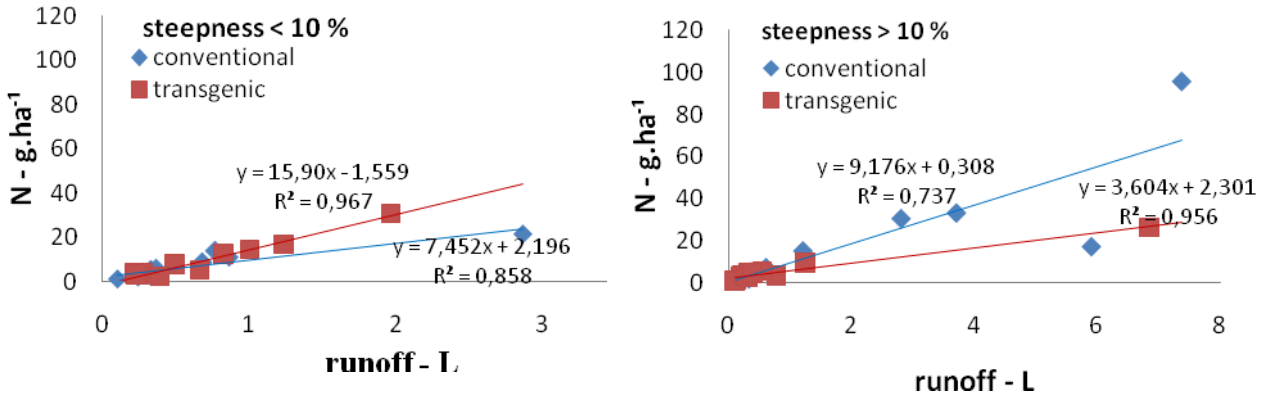

Figure 2 – Load of nitrogen in surface runoff on conventional soybeans and transgenic soybeans areas for two different steepness

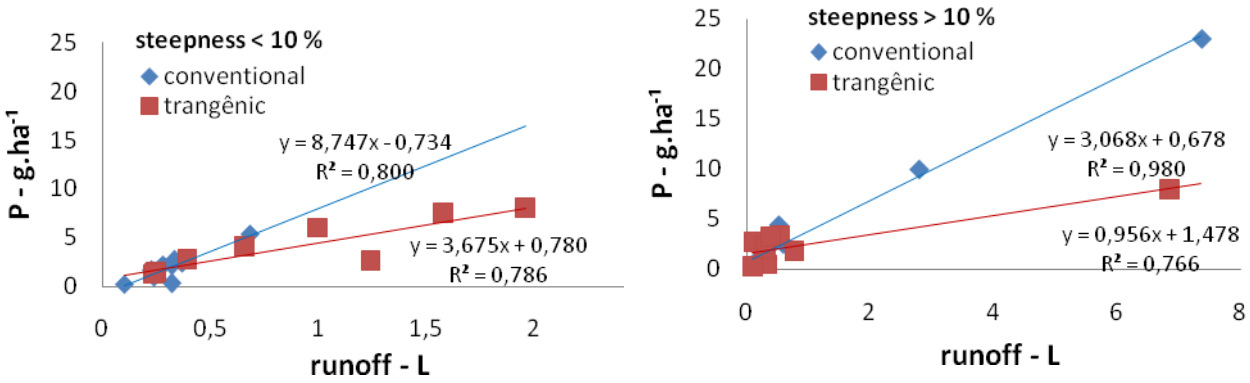

Figure 3 - Load of phosphorus in surface runoff on conventional soybeans and transgenic soybeans areas for two different steepness

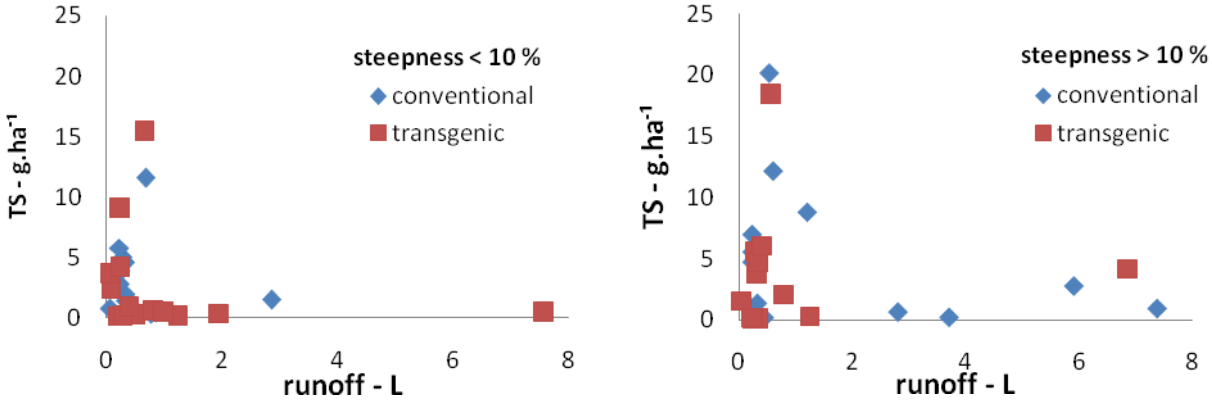

Figure 4 - Load of total solids in surface runoff on conventional soybeans and transgenic soybeans areas for two different steepness

The runoff characteristics of nutrient species were analyzed using nutrient load and surface runoff obtained over first four rainfall events, there was no significant effect ($p \leq 0.05$) of green cover concerning the obtained results, as well as steepness. Several representative indices for runoff, and nutrient load for each treatment were fitting adequately by linear regression with R^2 values between 0.77 and 0.98. However, no fitting was obtained for surface runoff and total solids. The regression models presented in Figure 2 show expected value of loss of N in transgenic soybean area is greater than ones in conventional soybean area for steepness < 10 %, while for steepness > 10 % the value expected of loss of N in conventional soybean area is greater than ones in transgenic soybean area. The expected loss of Pin conventional soybean area is greater than ones in transgenic soybean area for both slopes (Figure 3). The loss sediment load was evaluated by TS load presented in Figure 4. The results of TS suggest no effect occurred because conventional and transgenic soybean covers for both slopes.

In most agricultural watersheds, phosphorous transport are reported to occur mainly in surface runoff and soil erosion (Sharpley et al., 2003; Kim et al., 2006; Gentry et al.,2007) and the transport pathways of nitrogen are considered to be different from those of phosphorus (Stutter et al., 2008).

CONCLUSIONS

The results suggested that the nutrient loads of drainage water from the agricultural watershed with intensive agricultural production were greatly fitting by linear regression, resulting in the increases in expected nutrient concentrations of the receiving river when the surface runoff increases too. Although there was no significant effect ($p \leq 0.05$) of green cover occurred difference between expected values of N and P for conventional and transgenic soybean covers in both slopes.

ACKNOWLEDGEMENTS

]
This study was partly supported by CNPq. We express our gratitude

REFERENCES

Boesch, D.F., Brinsfield, R.B., Magnien, R.E., 2000. Chesapeake bay eutrophication: scientific understanding, ecosystem restoration, and challenges for agriculture. J. Environ. Qual. 30 (2), 303–320.

Carpenter, S.R., Caraco, N.F., Correll, D.L., Howarth, R.W., Sharpley, A.N., Smith, V.H.,1998. Nonpoint pollution of surface waters with phosphorus and nitrogen. Ecol.Appl. 8 (3), 559–568.

Gentry, L.E., David, M.B., Royer, T.V., Mitchell, C.A., Starks, K.M., 2007. Phosphorus transport pathways to streams in tile-drained agricultural watersheds. J.Environ. Qual. 36, 408–415.

Kim, J.S., Oh, S.Y., Oh, K.Y., 2006. Nutrient runoff from a Korean rice paddy watershed during multiple storm events in the growing season. J. Hydrol. 327(1–2), 128–139.

Sharpley, A.N., Daniel, T., Sims, T., Lemunyon, J., Stevens, R., Parry, R., 2003. Agricultural Phosphorus and Eutrophication. second ed. US Department of Agriculture, Agricultural Research Service, ARS 149.

Stutter, M.I., Langana, S.J., Cooper, R.J., 2008. Spatial contributions of diffuse inputs and within-channel processes to the form of stream water phosphorus over storm events. J. Hydrol. 350 (3–4), 203–214.

Tabuchi, T., 2005. Consideration of water quality conservation of lakes. Gihodoshuppan Co. Ltd., Tokyo, Japan.

Tilman, D., Fargione, J., Wolff, B., D'Antonio, C., Dobson, A., Howarth, R., Schindler, D.,Schlesinger, W.H., Simberloff, D., Swackhamer, D., 2001. Forecasting agriculturally driven global environmental change. Science 292 (5515), 281–284.