IMPACT OF SUGARCANE AND PEANUT ON NITROGEN AND PHOSPHORUS LOSSES IN THE MOGI-GUAÇU RIVER SUB-BASIN

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RESUMO: Sertãozinho-SP é um grande produtor de cana-de-açúcar e amendoim mundial. Na região usa-se a técnica de rotação de culturas que tem como objetivos a recuperação dos solos e o beneficiamento comercial dos produtores. O objetivo deste estudo foi quantificar as perdas nitrogênio, sob a influência da paisagem, seu uso e ocupação em dois sistemas de produção: amendoim e cana-de-açúcar, por meio da simulação do modelo SWAT. Foram mantidos para as duas culturas os atributos topográficos, as condições físicas e climáticas da sub-bacia hidrográfica do Rio Mogi-Guaçu, localizada no município de Sertãozinho – SP. De maneira geral, observaram as maiores perdas dos nutrientes na cultura do amendoim, quando comparada com a cultura da cana-de-açúcar, mostrando que os sistemas de produção e a quantidade de cobertura vegetal superficial impactaram nas perdas desses nutrientes. Os resultados mostraram que a simulação pode ser usada como uma ferramenta de gestão agrícola e para medidas políticas e ambientais, visando a conservação do solo e da água.

Palavras-chave: modelo SWAT; Rotação de culturas; Cana-de-açúcar e amendoim; Perdas de nitrogênio e fósforo.

ABSTRACT: Sertãozinho-SP is a major producer of sugarcane and peanuts in the world. In the region, the crop rotation technique is used, which aims to recover soils and commercially improve producers. The objective of this study was to quantify nitrogen losses, under the influence of the landscape, its use and occupation in two production systems: peanuts and sugarcane, through the simulation of the SWAT model. The topographic attributes, physical and climatic conditions of the Mogi-Guaçu River sub-basin, located in the municipality of Sertãozinho – SP, were maintained for both cultures. In general, they observed the greatest losses of nutrients in the peanut crop, when compared to the sugar cane crop, showing that the production systems and the amount of surface vegetation cover impacted the loss of these nutrients. The results showed that simulation can be used as an agricultural management tool and for political and environmental measures, aiming at soil and water conservation.

Keywords: SWAT model; Crop rotation; Sugarcane and peanuts; Nitrogen and phosphorus losses.

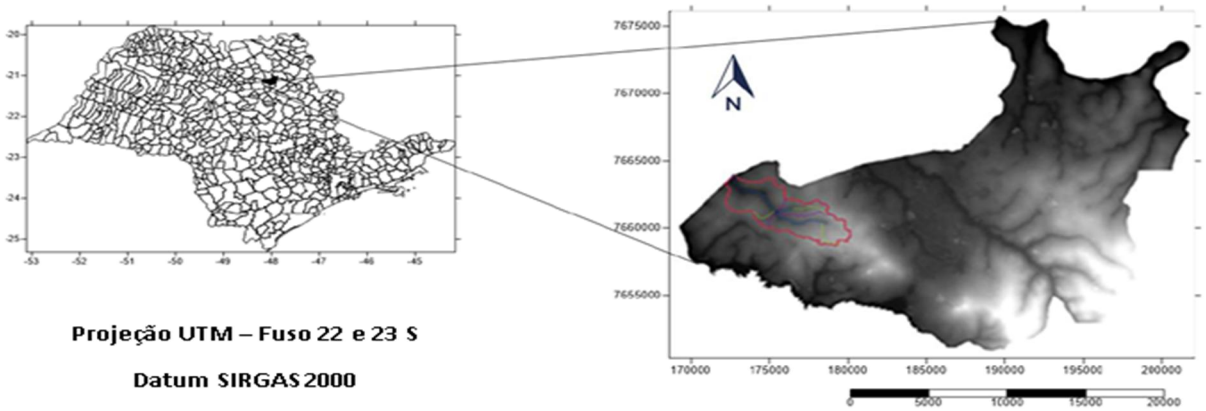
Introduction

Alta Mogiana region (Sertãozinho, Jaboticabal, Dumont and Ribeirão Preto) is one of the main centers for the production of peanuts and sugarcane in Brazil. In general, sugarcane producers sow peanuts in rotation. Crop rotation provides the annual alternation of plant species in the same productive area, whose chosen crops have commercial purposes and have the capacity to recover the soil. Generally, in sugarcane reforms, rotations are carried out by species called green manures that form a surface cover and promote the maintenance of the physical, chemical and biological properties of the soil. The most used plants in the region are *Crotalaria juncea*, soybeans and peanuts. The main benefits are: increased productivity, control of weeds, diseases and pests, improvement in soil fertility and physical characteristics, efficiency in the use of water and nutrients, optimization of the use of machines in ownership and risk reduction of crop yield losses (CHRISTOFFOLETI et al., 2007). Besides, when plant residues are left or kept in direct contact with the soil surface, they are extremely efficient in controlling the erosion process in between furrows. The aim of this study was to quantify nitrogen and phosphorus losses under the influence of landscape and land use and occupation of two production systems, peanuts and sugarcane, by simulating the SWAT model, keeping for both crops the topographic characteristics and the physical and climatic factors of the Mogi-Guaçu River sub-basin, located in the municipality of Sertãozinho – SP.

Methodology

The municipality of Sertãozinho is located in the Center-North region of the State of São Paulo, located in the Planalto Ocidental Paulista, under the geographic coordinates 21º 08' 16" South Latitude and 47º 59' 25" West Longitude of Greenwich. It has a territorial area of approximately 403.89 km² (IBGE, 2010). According to Köppen's classification, the climate is Aw, tropical, wet summer and dry winter. The average annual temperature in the region is 22.8 °C, the average annual rainfall is around 1,588.5 mm. The predominant relief is soft-wavy and wavy, with altitude ranging from 310 m to 610 m. The municipality is located in the Mogi-Guaçu Basin, located under the Alta Mogiana region and the predominant vegetation cover is the Cerrado (IBGE, 2010). The digital elevation model (DEM) of the study area was acquired through the worldwide HydroSHEDS – USGS database, whose approximate resolution is 1 kilometer. Figure 1 shows the MDE for the municipality of Sertãozinho – SP, highlighted in red for the sub-basin under study. For the preparation of the soil map, the pedological model provided by the Brazilian Agricultural Research Corporation (EMBRAPA, 1999) was used, based on the Brazilian soil classification system (IBGE, 2001). The land use and occupation map were obtained by joining the bands provided by the Landsat-8 satellite. The temporal resolution used was 16 days and the spatial resolution was 30 meters for the visible bands.

Figure 01 – Digital map of digital elevation of the city of Sertãozinho – SP. Demarcation of the study sub-basin of the Mogi Guaçu basin (red).



Source: Own (2020)

The climate data were taken from the system of the National Centers for Environmental Forecasting (NCEP), which belongs to the Reanalysis of the Climate Forecasting System (CFSR), where precipitation, wind, relative humidity and solar data were collected in the SWAT file format, from 1979 to 2014. The software used was ArcSWAT, together with ArcGIS 10.3 for the analysis of phosphorus and nitrogen losses for dry crops. The calculations of production and transport of these nutrients are in the manual “Soil and Water Wssessment Tool Theoretical Documentation Version 2009” (NEITSCH et al 2011).

Results and discussion

It was observed that crops interfered with the forecast and the way in which nitrogen and phosphorus was lost. Peanut production showed the highest nitrogen losses according to the simulation, totaling 118.44 kg / ha, while in the sugarcane crop this loss was 34.48 kg / ha. This difference may have occurred because a peanut crop requires more nitrogen than sugarcane, eliminating a greater loss of this nutrient. When the total amounts lost from runoff, leaching, lateral flow and nitrate groundwater were compared, the largest losses in sugarcane were observed, 0.46 kg/ha (1.3%), 32.74 kg/ha (95%), 0.19 kg/ha (0.5%) and 0.69 kg/ha (2%), respectively. In the peanut crop, the losses were 0.34 kg/ha (0.3%), 85.99 kg/ha (72.6%), 0.37 kg/ha (0.3%) and 1 .84 kg/ha (1.6%). The main form of nitrogen loss in both production systems occurred through leaching, showing that this process occurred with greater intensity in sugarcane cultivation. Leaching helped in the accumulation of nitrogen in groundwater, being an indicative loss. For the lost amounts of organic nitrogen, the highest were in the peanut crop, totaling 29.90 kg/ha, representing 25.2% of the total loss. As for the sugarcane crop, the amount lost was 0.4 kg/ha, which represented 1.2% of the total loss (Table 1). The characteristics of production systems in peanuts promote greater mineralization of organic N due to microbial activity, facilitating the loss of this source, when compared to sugarcane.

Table 01 - Estimate of nitrogen losses in the sub- watershed of Mogi-Guaçu River.

Loss index	Sugarcane (kg/ha)	Percentage (%)	Peanut (kg/ha)	Percentage (%)
Total Nitrogen Loss	34,48	100	118,44	100
Organic nitrogen	0.40	1.20	29.90	25.20
Nitrate superficial runoff	0.46	1.30	0.34	0.30
Leachate nitrate	32.74	95.00	85.99	72.60
Nitrate lateral flow	0.19	0.50	0.37	0.30
Groundwater nitrate	0.69	2.00	1.84	1.60

Source: Own (2020)

They observed that the peanut crop production system showed the greatest loss of phosphorus according to the simulation, amounting to 5.46 kg/ha, whereas for the sugarcane crop a loss of 0.805 kg/ha was recorded. Soil exposure collaborates with water erosion, which in turn has a more intense impact on the management adopted in peanut cultivation, resulting in greater loss of phosphorus. The main reason for this was the variation in the amounts of soil and water lost between the treatments studied, as the concentrations of P were higher in no-tillage than in the other treatments (Table 02).

Table 02 - Estimate of phosphorus losses in the sub- watershed of Mogi-Guaçu River.

Loss index	Sugarcane (kg/ha)	Percentage (%)	Peanut (kg/ha)	Percentage (%)
Total loss of phosphorus	0.805	100	5.456	100
Organic phosphorus	0.113	14.0	5.205	95.4
Runoff of soluble phosphorus	0.692	86.0	0.251	4.6

Source: Own (2020)

The greatest losses of organic phosphorus were observed in the peanut crop (5,205 kg / ha, representing 95.4% of the total losses in the crop). For the sugarcane crop, the loss was 0.113 kg/ha, representing 14% of the total loss. Regarding the surface runoff of soluble P, the sugarcane showed the highest amount and also the highest loss rate, with 0.692 kg/ha and 86%, respectively. For peanuts, it was 0.251 kg / ha (4.6%). Phosphorus is not barely mobile in the soil, the action of microorganisms in sugarcane cultivation and the decomposition of straw impact the P reactions in the soil, which together with moisture, cause a greater surface runoff in sugarcane, when compared to peanuts. In addition, Legumes are much more demanding, as the root system is superficial and the cycle is specifically shorter, needing to adsorb larger amounts of nitrogen (GOMES JÚNIOR et al. 2008) and phosforus, especially in the no-tillage system when cultivated in succession to grasses.

Final considerations

The Swat tool estimated the nitrogen and phosphorus losses, showing that the management, occupation and landscape of the soil influenced this process, where the biggest losses were in the production of peanuts. Swat can be a management tool, assisting in decisions regarding environmental policies, collaborating with soil and water conservation in Brazilian sub-basins.

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