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SHIFT

Projeto Capoeira

Seminário sobre manejo da Vegetação Secundária para a Sustentabilidade da Agricultura Familiar da Amazônia Oriental

Anais

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Slash and mulch to reduce nutrient losses in shifting cultivation in the Eastern Amazon

R. Sommer; P. L. G. Vlek; H. Fölster; T. D. de A. Sá

Introduction

Detailed studies on nutrient balances in the slash-and-burn system in the micro-region Bragantina in Pará/Brazil were already conducted in Shift-Capoeira's first project phase. Hölscher (1997) using a climatological approach showed that the nutrient input-output-budget for a rotation period of 9 years was not balanced. The huge gaseous losses of several nutrients when burning the slashed secondary vegetation could not be compensated through atmospheric inputs during a fallow period of seven years. K, Ca, Mg as well as N and S showed a negative outcome. Solute nutrient losses by leaching were found to be relatively small compared to those through burning. To achieve a balanced nutrient flow, the length of the fallow period would have to be extremely prolonged (>100 years), which is not feasible. Therefore, mulching instead of burning is seen as a promising alternative (see also Kato, 1999).

This paper studies the effects of this alternative land preparation on the nutrient dynamics during the subsequent cropping phase. It was supposed that applying large amounts of biomass to the soil surface would lead to higher loss of nutrients by leaching. Therefore, the movement of solute nutrients in the soil profile was especially considered. Results were compared with those of traditionally burned fields and with a three-year-old secondary vegetation.

Methods

The balance of the above-ground nutrient dynamics were calculated determining the nutrient input and output-quantities (fertiliser, atmospheric deposition, gaseous losses and extraction of harvest products and of firewood).

To investigate the leaching losses concentrations of solute nutrients were combined with a soil-water balance. Therefore, samples of soil water solution were taken biweekly using suction cups. Additionally, the annual patterns of the matric potential at different depth of the soil profile were recorded (tensiometer). The Soil water movement then was modelled using laboratory pF-chracteristics and pedo-transfer functions.

Microclimatic parameters (precipitation, radiation, air humidity, wind speed) were determined to predict the potential evapotranspiration, a so called 'sink-tem' in the soil-water model.

All measurements were conducted over 1.5 years of traditional agricultural land use (maize-beans-cassava) and at the same time in a three-year-old secondary vegetation (Capoeira).

Starting the agricultural phase, in November/December 1996 two different fields with secondary vegetation, 3.5 respectively 7 years old, were slashed. The age of the preceding secondary vegetation represents the actual minimum respectively maximum fallow length of traditional slash-and-burn agriculture.

One half of each field then was burned, the other was mulched. (At the time a tractor-force-driven modified maize chopper was used.)

Tensiometers and suction cups were installed horizontally, slightly inclined in 3 m and 6 m deep soil pits on every field in every treatment (mulched, burned) and in the three-year-old secondary vegetation.

Micro-meteorological measurements and the tensiometer readings were taken automatically every fifteen minutes with a solar-energy supplied data logger system.

The result of the tensiometer readings under the three-year-old secondary vegetation provides information about the secondary vegetation's water demand and its effect on desiccation of the soil profile during the dry-season in 1997 (data not shown here, see poster session). The solute nutrient concentration under the secondary vegetation have to be seen as the natural status of leaching of a fallow vegetation (= 0-treatment).

Results and Discussion

The balance of above ground nutrient dynamics are shown in Table 1 and Table 2 for both fields studied. In the burnt treatments N as well as K, Ca, Mg and S showed a negative balance. In the mulched treatments this was only the case for N and also for K following the younger secondary vegetation, where lower deposition quantities occurred. The other elements considered achieved a slightly positive balance due to the fire-free land preparation technique. P in both field preparations and on both fields gained a positive outcome that was effected by the fertiliser input of 48 kg P ha^{-1}. Despite the higher total N-losses of the burned treatment followed the 7 years of fallow (higher volatilisation losses), N-losses amount to -50 kg ha^{-1} y^{-1} when calculated on an annual basis over the entire fallow/crop cycle, irrespectively of the length of the fallow cycle.

Table 1: Above-ground nutrient balance after 3.5 years of fallow and subsequent 1.5 years of agricultural land use (total cycle = 5 years).

Component	TM	C	N	P	K	Ca	Mg	S
					[kg ha^{-1}]			
Deposition*			13	4	11	28	14	20
Fertiliser			70	48	66	0	0	0
Burning	-27524	-13179	-236	-5	-61	-141	-27	-30
Firewood	-312	-147	-1.3	-0.1	-1.1	-2.2	-0.3	-0.3
Harvest			-120.8	-22.2	-79.8	-14.4	-12.5	-7.1
BNF			?					
Leaching			?	?	?	?	?	?
burned			-274.6	24.5	-65.3	-130.5	-25.8	-17.8
mulched			-37.8	29.8	-2.9	13.1	1.5	12.9

(* according to Hölscher, 1995)

Table 2: Above-ground nutrient balance after 7 years of fallow and subsequent 1.5 years of agricultural land use (total cycle = 8.5 years).

Component	TM	C	N	P	K	Ca	Mg	S
					[kg ha^{-1}]			
Deposition*			22	7	18	47	24	34
Fertiliser			70	48	66	0	0	0
Burning	-43358	-20792	-355	-10	-144	-173	-46	-45
Firewood	-1736	-820	-7.1	-0.5	-6.1	-12.1	-1.8	-1.8
Harvest			-120.8	-22.2	-79.8	-14.4	-12.5	-7.1
BNF			?					
Leaching			?	?	?	?	?	?
burned			-391.2	22.4	-146.1	-152.7	-36.4	-20.3
mulched			-28.7	32.6	4.5	32.3	11.3	26.9

(* according to Hölscher, 1995)

The quantities for leaching as well as for the biological N fixation (BNF) remain unknown as elaboration of results are still not completed. Thielen-Klinge (1997) investigating the role of natural N_2-fixation in the Bragantina Region assumed annual BNF rates between 0.1 and 4.7 kg N ha^{-1} y^{-1} for secondary vegetation of different age. Adding 4.7 kg N ha^{-1} y^{-1} would not really improve the balance of burned fields but lead to a positive balance for a cropping cycle lasting 8.5year. More details on BNF are given by Papar iková et al. (see Abstract in this publication).

Preliminary results regarding concentrations of solute nutrients did not indicate higher nutrient concentrations in the soil solution under the mulched treatments compared to those in burned ones during the cropping phase. Example for N and K are shown in Figure 1 and Figure 2, respectively. The burned treatment, at least initially, seemed to release more NO_3^- to the soil solution than did the mulched one.

Thus, it seems that decomposition of the mulched above-ground biomass does not lead to higher below-ground nutrient levels. Therefore, fire-free land preparation can improve the nutrient balance of shifting cultivation avoiding nutrient losses through volatilisation without increasing losses through leaching.

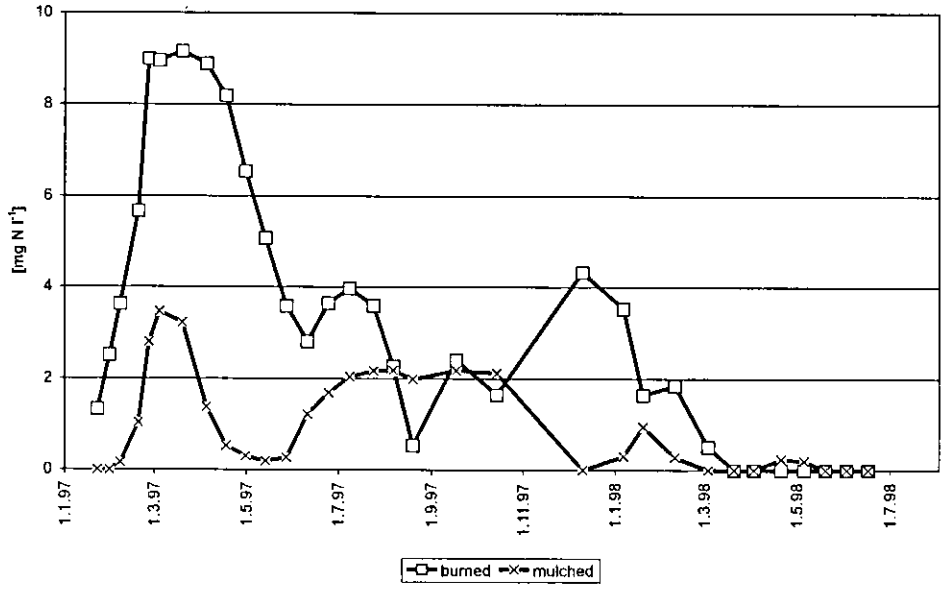

Figure 1: Nitrate concentration in the soil solution in 90 cm depth during the cropping phase related to different land preparation techniques (total cropping cycle in this case 8.5 years).

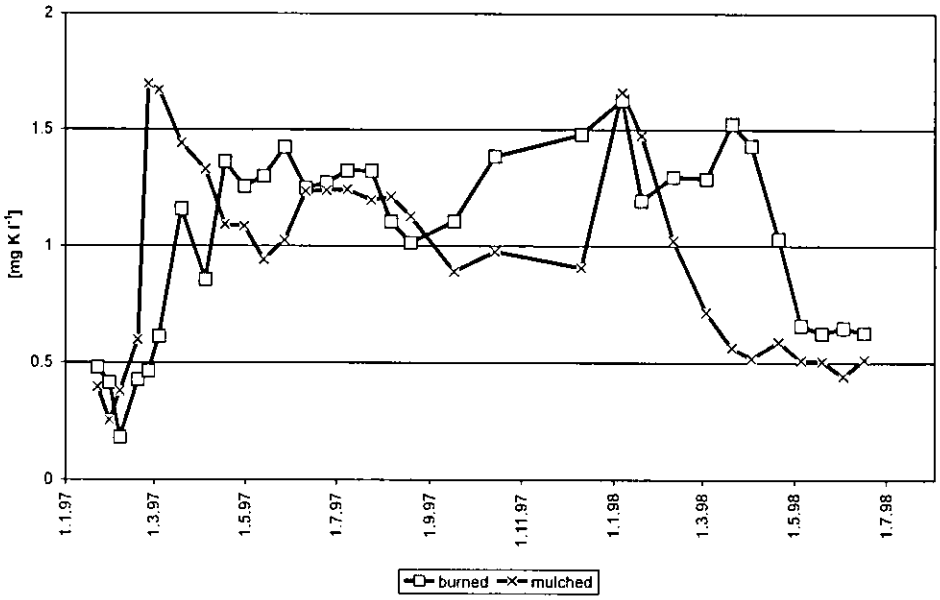

Figure 2: K^+ concentration in the soil solution in 90 cm depth during the cropping phase related to different land preparation techniques (total cropping cycle in this case 8.5 years).

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