Patterns in Tropical Grass Silicification: Response to Substrate Fertilization

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Patterns in tropical grass silicification : response to substrate fertilization

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Introduction Silica is accumulated mostly in grasses . The effect of soil properties has not been much documented . Proportions of silica in plants decreased on raising the soil pH and concentration in soil decrease with higher value of pH (Jones & Handreck 1965) . There is a quantitative relationship between silica concentration in the soil solution and the amount taken up by plants . We explore the hypothesis that soil fertility (N-P-K) influences leaf silicification of tropical fodder grass species . The response of plant silica concentration to substrate fertilization in 5 grass species was examined , as well as silica relationships with leaf structural parameters tightly correlated with leaf functioning .

Materials and methods The experimental garden of the Faculty of Agronomic Sciences of Abomey-Calavi University in Benin belongs to a subequatorial climate with 2 dry seasons : mid-July to mid-September , and mid-November to mid-March . Precipitation averaged 1197 mm in 2002 with 278 mm from January to May , the experimental period . Plots were well watered . Soil is sandy loam , acid , with a fragile structure , poor in exchangeable bases , phosphorus , but with appreciable sodium concentration ; N standard level of the experimental site was 0 .08% N , and C/N mass ratio is 10. 6 . Five tropical fodder grass species were studied : *Andropogon gayanus* var . *Bisquamulatus* (Hochst .) Hack ., *Hyparrhenia smithiana* (Nees ex Steud) Clayton , *Panicum maximum* var . C1 , *Panicum maximum* Jacq and *Pennisetum purpureum* Schumach . Clumps from various climatic areas were established on 25th September 2002 in plots at Abomey-Calavi . Eight tillers per clump were planted in each plot sized 4 m×6 m . Design was 2 treatments×5 species×5 replicates . Nutrients were initiated 30 days after transplantation , on 28th October 2002 . 100 g of $CaH_4(PO4)_2$ 56% P_2O_5 and 100 g of Urea 46% N , were directly applied per m in form of granules around each treated clump and tap watered at 1 L per clump per day . Plants were harvested in April 2003 . Ten standardized leaf blades , bulks of sheaths and blades were sampled . Leaves were washed and stored . Bulk sheaths and blades and 40 samples of 10 blades were harvested . SLA was estimated from leaf fragments . Samples were oven dried at 65℃ for 48 h for dry matter DM was calculated and relative water content (RWC) as % RWC = 100 × (1 DM/FM) . Silica (SiO_2) and soluble ashes (SA) concentrations were analyzed in bulk samples . Silica was analyzed gravimetrically by dry ashing , and weighted and SA calculated as (total ashes silica) . ODM = DM-SiO_2 (1) ; SA = 100 × (TA-SiO_2)/ODM (2) ; % SiO_2 = 100 × SiO_2/ODM (3) ; DM = dry matter , ODM = Organic Dry Matter ; TA = Total Ashes . 80 bulk samples of blades and sheaths were analyzed for silica and soluble ashes concentrations . Statistical analyses were performed using STATISTICA 6 .0 . ANOVA was performed with species and fertilization . Relationships between silica and SA , RWC and SLA were assessed using Pearson correlation coefficients .

Results Dry mass production ranged from 430 to 1200 gm^{-2} , depending on treatments and species . Variations were significant with the highest values in *Andropogon gayanus* var . *Bisquamulatus* (AGB) (> 1200 gm^{-2}) and the lowest in *Pennisetum purpureum* (< 450 gm^{-2}) . The highest production belongs to fertilized treatments . Substrate fertilization was significant on the plant SiO_2 concentration . Values were higher in blades compared to sheaths except for *Hyparrhenia smithiana* were the reverse was true . Mean values ranged from 2 .13% to 4 .83% of DM in blades and 1 .51% to 4 .20% in sheaths , depending on species and treatments . The effect of fertilization varied depending on species ($P < 0.001$) . SiO_2 in blades generally decreased except *Panicum maximum* Jacq (PMJ) . SiO_2 in sheaths consistently decreased . SiO_2 decreased both in blades and sheaths for *P . purpureum* (PP) , *H . smithiana* (HSm) and AGB . Magnitude ranged from 29% to 54% in blades , and from 17% to 59% in sheaths depending of species . The impact of fertilization was not significant for *Panicum* accessions . Comparing 10 observations (i .e . blades + sheaths) , SiO_2 concentration decreased in the fertilized treatments in 9 cases and significantly so in 6 cases . RWC , SA and SLA were significantly affected . This indicates a rather specific pattern of variation of leaf traits in response to fertilization depending on species . The response of other traits was more complex compared to SiO_2 . SiO2 positively correlated with SA in blades , so with RWC in control treatment but negatively in the fertilized . Plant silica generally decreased with substrate fertilization consistently with previous results on *Bouteloua gracilis* (Pieper *et al* . 1974) . This might be a consequence of enhanced biomass production , i .e . dilution effect (Griffin *et al* ., 2002) .

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