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Effect of Fire on Tiller Regeneration of Tussocks and Soil Physico-chemical properties in Derived Savanna Zone of Nigeria

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Abstract: *Most Savanna species regenerate both sexually and asexually, especially following disturbances such as fire and selective cutting. The research study on fire experiment was conducted around Egume Derived Savanna in Kogi State, Nigeria to assess the effect of fire on tiller regeneration of tussocks and physico-chemical properties of soil of the study area. The experiment was performed in three plots (i.e. the burnt, slashed and control). The total percentage mean of tiller regeneration of the tussocks recorded in the burnt plot was significantly (P<0.05) higher as compared to the slashed and the control plots. The relative low tiller regeneration of tussocks in the control plot may be as the result of the shading effect of the dry shoot of the tussocks on the new ones from receiving adequate sunlight and also competition among the new shoots for available soil water and mineral nutrients. The results of the physico-chemical analysis of soil of the study area also revealed significantly (P<0.05) higher % values in all the plots especially the burnt plot. The estimated high tiller density recorded during the study shows the high carrying capacity of the study area with the fertile soil that is continuously covered by herbaceous materials.*

Keywords: *Tiller regeneration, Tussocks, soil physico-chemical, Derived Savanna, fire, plots.*

I. Introduction

Tropical dry forests including savannas are the most threatened tropical terrestrial ecosystems. However, their restoration through natural regeneration (the natural process whereby plants replace or reestablish themselves) needs continued investigations (Vieira and Scariot, 2006). Most savanna species regenerate both sexually and asexually, especially following disturbances, such as fire and selective cutting (Bationo et al., 2001a and Zida et al., 2007). Vegetative regeneration from dormant or newly formed buds on parent stumps, roots or other organs is prevalent in many savanna species, especially following disturbance (Bellefontaine, 1997; Gignoux et al., 1997; Hoffmann, 1998; Sawadogo et al., 2002; Bognounou et al., 2010). Frequent disturbances such as fires may influence the relative abundance of species that are able to reproduce vegetatively, causing a shift in species composition, favoring species capable of vegetative reproduction (Hoffmann, 1998). This research on fire experiment was conducted around Egume Derived Savanna in Kogi State, Nigeria to assess the effect of fire on tiller regeneration of tussocks and physico-chemical properties of soil of the study area.

II. Materials And Methods

Determination of the Effect of Fire on Tiller Regeneration of the study Area

Three plots (A, B and C) of one hectare each were located, following Usman (1990) and Sagar (2008) procedures to mark out the plots using paces (one pace being an equivalent of one meter). Fire trace was made around each of the plots. Controlled (prescribed) burning was administered in the first plot (A) in March when all the herbaceous materials were thoroughly dried. The second plot (B) was slashed to the ground level using cutlass and raked out and the third plot (C) remained standing, representing the control plot. These plots were visited on weekly basis and were maintained from March till October when most herbaceous plants were in their flowering period. Enclosures were made around all the three plots at the beginning of the experiment to keep off livestock. And in each plot, 20 tussocks each of dominant grass species were marked out and pegged for weekly observation of new flush or tiller regeneration. The weekly numbers of new tillers were recorded against every pegged tussock in the 3 plots.

Soil Sampling.

Soil samples were obtained at 0- 10cm depth along each of the four cardinal directions within the $1m^2$quadrat using soil auger (5cm diameter) from the three plots (i.e. Burnt, Slashed and the Control). All the soil samples within the quadrat were bulked together, mixed and sieved through a 2mm meshed wire. The soil samples were oven-dried at 70^oC for 24 hours and analyzed chemically for Organic carbon using the Walkley-Black method by Black et al.(1965); Total nitrogen by wet-digestion method, available soil phosphorus using

the double acid method and the soil pH using the method described by Peech (1965).The soil bulk density was determined following Kahi et al.(2009).

Data Analysis

The data obtained during the study were subjected to One-way Analysis of Variance (ANOVA) and the mean values were compared by T-test using statistical software for social sciences (SPSS) version 19.

III. Results

Tiller Regeneration of Tussocks in the three Plots

The total percentage (%) mean of the tiller regeneration during the study in three plots was 29951.03m^{-2}. The burnt plot recorded a significant (12927.70m^{-2})" followed by the slashed plot with the % mean of 9946.00m^{-2}. While the control plot recorded significantly lowest (7077.33m^{-2}) in tiller regeneration among other plots (Table1).

Soil Analysis for the Three Experimental Plots.

The results of the physico-chemical analysis of the soils in the three experimental plots are presented in Table2. The percentage (%) organic carbon, total nitrogen, soil pH and the soil bulk density of the burnt plot were significantly highest with exception of available phosphorus which was found to be lowest in the plot. However, the control plot recorded a significantly ($P<0.05$) highest in the amount of available soil phosphorus.

Table 1: Mean Number of Tiller Regeneration of Tussocks in the three plots

Experimental Site	Mean number of new flush (M^{-2})	% mean Regeneration (%MR) (M^{-2})
Burnt plot (A)	387.83	12927.70
Slashed plot(B)	298.38	9946.00
Standing plot(C)	212.32	7077.33
Total	**898.53**	**29951.03**

% MR = Percentage mean regeneration = Total mean/3 experimental sites (plots).
P = value of 0.05 level of significance.

Table 2: Soil Analysis for the Three Experimental (Burnt, Slashed and Standing) Plots

Soil parameter	Experimental Plots		
	Burnt	Slashed	Standing (control)
% Organic Carbon	1.46 ± 0.02	1.34 ± 0.02	1.26 ± 0.02
% Total Nitrogen	1.12 ± 0.25	1.07 ± 0.01	1.0 2 ± 0.02
Available soil phosphorus	532 ± 0.04	546 ± 0.01	626 ± 0.08
Soil pH	7.19 ± 0.02	6.04 ± 0.02	6.14 ± 0.02
Soil bulk density	1.19 ± 0.01	1.16 ± 0.01	1.04 ± 0.01

IV. Discussion

Tiller Regeneration of Tussocks and Soil analysis of the Three Experimental Plots

The total percentage mean of the tiller regeneration of the tussocks recorded in the burnt plot was significantly ($P<0.05$) more as compared to the slashed and control plots. This is because, in fire-prone environments, herbaceous plants recover and regenerate after fire and since they attain maturity in just one growing season most or all of the native perennial herbaceous plants have survived fire and sprout readily after burning (Kurt, 2004). It has been also reported by Kurt (2004) and Aina et al (2013) that, fire releases minerals in bulk in form of ash instead of the usual slow process of decay. These ashes from the burnt phytomass (biomass) have considerable impact on soil and vegetation. Burning of biomass increases the nutrient of the burnt plot as reflected in the results of the soil analysis of this study. The resultant effect of burning enriched the soil, therefore resulting in rapid growth and increase in tiller regeneration density of 12927.70 m^{-2} compared to 9946.00 m^{-2} and 7077.33 m^{-2} for slashed and control plots, respectively.

The low tiller regeneration of the tussocks in the control plot may be as a result of the shading effect of the dry shoot of the tussocks on the new ones (tiller) from receiving adequate sunlight and also competition among the new shoots for available soil water and mineral nutrients. And these resulted in delayed, stunted growth and decreased tiller generation density at the end of the growing season as is reported by Brown and Smith (2000), Kurt (2004) and Aina et al (2013).

The results of the physiochemical analysis of soil in this study revealed significantly ($P<0.05$) higher % values in all the plots most especially the burnt plot. The high % values of organic carbon, total nitrogen, soil pH and available phosphorus even in the control plot are relatively higher than those reported by Wasonga (2001) and Kahi et al. (2009) in Kenya. This is a clear indication that the soil is fertile.

Conclusively, the estimated tiller density of 29951.03 m^{-2} from this study shows high carrying capacity of the study area with the fertile soil that is continuously covered by herbaceous materials. The composition of the soil in the environment may give an insight to the plants that will likely flourish in the area.

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