Impact of Irrigation, Cutting, and Fertilization on the Phenology of Sahelian ranges.

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Abstract

The main source of feed of Sahelian livestock is the annual herbaceous layer of Sahelian rangeland. The annual grass has a quick growth during the rainy season. The growth stop when the grass is flowering because of the photoperiod. The study of phenology is a key factor for the understanding of herbaceous growth. The objective of our study was to evaluate the impact of management on phenology. On ungrazed rangeland in northern Senegal, we tested 22 different irrigation, cutting, and fertilization treatments repeated four times. Treatments included water regime (rainfall with and without irrigation), cutting (height and period of cutting), and fertilization (cattle manure). Each water regime was composed of treatments coupled or not with cutting or fertilization. We monitored the phenology of each treatment every ten days. The phenology was noted in three categories: vegetative stage, reproductive stage, senescence stage. At the beginning of the rainy season, before cutting, irrigation has effect on vegetative stage. During the season, this effect disappeared. Only the effect of cutting is expressed until the end of the season on the three phenological stage. This study confirms previous results that showed that phenology is mostly influenced by cutting in the Sahel region.

Keywords: Northern Senegal, Ungrazed, Herbaceous, Cattle manure, Rainfall

Introduction

Herbaceous layer plays an important role in livestock production in the Sahel. It is the principal source of feed for livestock in the pastoral system, which is one of the main economic resources in the Sahel (Akpo et al., 2003; Diop, 2007). This vegetation is strongly dependent on rainfall (annual variations, quantity, and distribution of rainfall) and influenced by the management practices adopted by the population. The study of phenology is a key factor in understanding herbaceous growth. However, the information about the impact of irrigation, cutting and fertilization on the Phenology of Sahelian rangelands is lacking. The objective of this study was to evaluate the impact of management practices and the water regime on the phenology of the herbaceous layer at Sahlien Rangelands.

Material and methods

The trial was conducted on an ungrazed site at the Centre de Recherches Zootechniques (CRZ) of Dahra in northern Senegal. Eighty-eight plots of 1 m^2 were delimited and 22 different irrigation, cutting, and fertilization treatments were tested. The total cumulative rainfall received by the plots was 379.2 mm. The treatment description is presented in Table I. We evaluated the relative coverage of plants at the vegetative stage (%V), reproductive stage (%F), and senescence (%S) by plot. The non-parametric test of Kruskal Wallis and the Dunn.test function were used to compare the phenological stage between the treatments using the version 4.1.2. of R software.

Table I. Lists of treatments carried out

Treatments	Quantity of water (mm/m^2)	Start date of irrigation (2021)	Duration (months)	Cutting height	Cutting period	Fertilizer ($kg\ ha^{-1}$)
2						
1	120	mid-July	1			
3	120	mid-August	1			
4	100	mid-July	2			
5	100	mid-August	2			
6				low to the ground	27/07/21	
7				low to the ground	04/09/21	
11				5 cm from the ground	27/07/21	
12				5 cm from the ground	04/09/21	
10	100	mid-July	2	low to the ground	27/07/21	
8	100	mid-July	2	low to the ground	04/09/21	
9	100	mid-July	2	5 cm from the ground	27/07/21	
13	100	mid-July	2	5 cm from the ground	04/09/21	
14	100	mid-August	2	low to the ground	27/07/21	
15	100	mid-August	2	low to the ground	04/09/21	
16	100	mid-August	2	5 cm from the ground	27/07/21	
17	100	mid-August	2	5 cm from the ground	04/09/21	
18						1,000
19						2,000
20	100	mid-July	2			1,000
21	100	mid-July	2			2,000
22	100	mid-August	2			1,000

Results and discussion

On July 27, 2021, the %V of irrigated treatment 8 (64±11%), was significantly lower than treatments 6 (92±5%), 16 (86±10%), 17 (94±3%), 15 (85±17%), that only received rain water. Irrigated plot10 (78±13%) had a significantly lower %V than plot 17 (94±3%) that received only rain water. Fertilized plots 19 (86±18%) and 20 (89±9%) had a higher %V than plot 8 (64±11%). Cutting effect was observed on treatments 6 to 17 refers to table 1. On September 23, the cutting plot 7 has a significantly %V and %F than the control 2 (respectively %V: 45±30% vs 98±2% and %F: 55±30% vs 3±2%). Early cut %V and %F was significantly lower in treatments 10, 11, and 16 (respectively %F: 98±1%, 97±1%, 98±1%, and %V: 3±1%, 4±1%, 2±1%), than late cut treatments 12 and 13 (respectively %V: 71±23%, 56±23% and %F: 29±23%, 44±23%). On October 12, irrigated at mid-July and cut 5 cm above ground plot 13 had a lower %V than plot 7 not irrigated and cut low to the ground (%V: 1±1% vs 6±4%). Irrigated at mid-July and cut at 5 cm above ground Plot 14 (%S 6±7%) had a lower %S than plots 11 and 9 both irrigated at mid-July and cut low to the ground (respectively %S: 47±25%, 47±27%). Treatment 11 (%F 53±25%) had a significantly lower %F than 14 (%F 94±6%).
These results show that at the beginning of the season and irrigation induces a reduction of the %V of the irrigated treatments. Indeed, the irrigated plots started to flower faster than the others. The sensitivity of the herbaceous layer to the variation of water resources has been noted in the literature (Richard et al., 2019), particularly at the beginning of the season (July) by Diawara et al., (2020) in Burkina Faso. Also, fertilization associated or not with irrigation leads to an increase of more than 20% of the %V. During the rainy season, the effect of irrigation and fertilization disappeared and the cutting period, in particular, had a significant effect on the %V and %F. Indeed, at this period, rainfall become frequent and enought to satisfy the water needs of all plants. Plants in the cut plots resuming their cycle while those in the non-cut treatments

continuing theirs. At the end of the season, in addition to the effect of the cutting period on the %V and %F, an effect of the cutting height, coupled or not with irrigation, appeared on vegetative, flowering, and senescence. The influence of cutting height and timing on the ability of grasses to regrow, and thus resume their cycle has been noted by Klein et al. (2013).

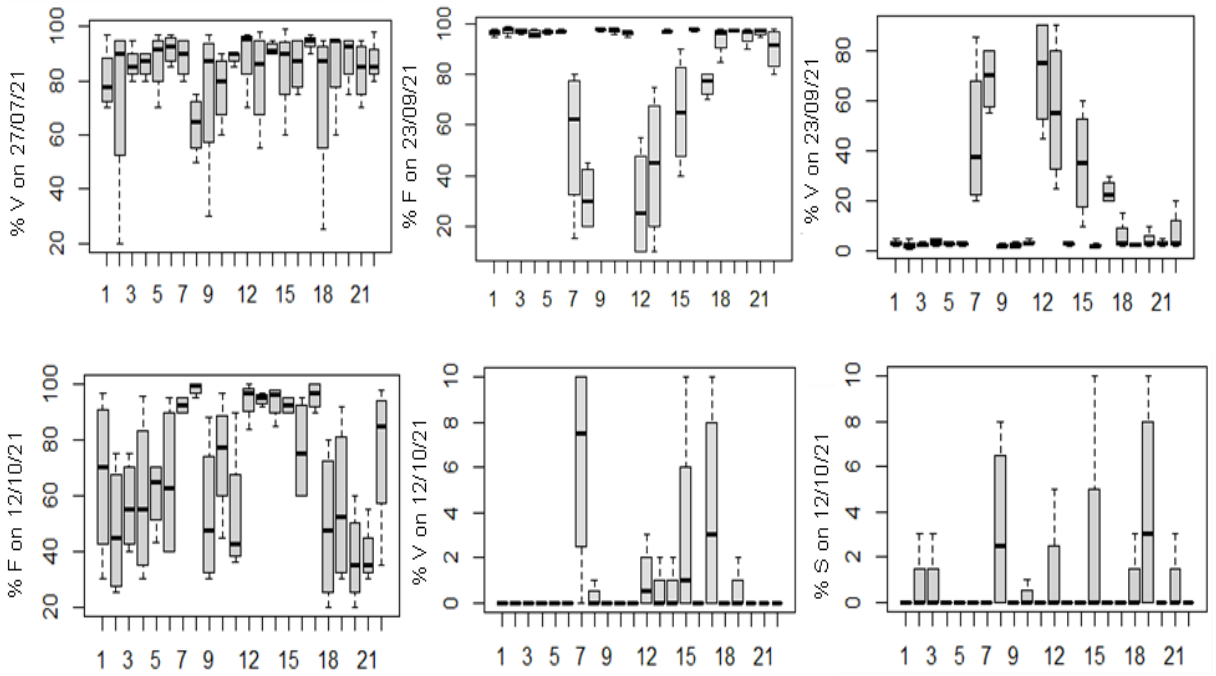

Figure 1. Average percentage of the vegetative stage (%V), flowering stage (%F), and/or senescence (%S) stage at different herbaceous vegetation monitoring dates at CRZ Dahra; x-axis refers to the treatments in table 1

Conclusion

This study shows that the effect of fertilization, irrigation, and cutting on phenology differs according to the phenological stage and rainfall. Indeed, at the beginning of the rainy season, before cutting, irrigation has a negative effect on leafing. Then, during the season, when the rains become regular and allow to satisfy the needs of the plants this effect disappears. Only the effect of cutting is expressed until the end of the season. This study shows that at the beginning of the season the phenology can be influenced by the water resources and the quantity of organic matter in the soil. However, when the rainfall becomes enough to satisfy the needs of the plants this effect disappears.

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