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Acceptability of plant species along grazing gradients around watering points in Tunisian arid zone

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ABSTRACT

Water points provide excellent sites for studying overgrazing effects on plant communities in dry areas. Distance from water can be considered like a surrogate of grazing pressure being high near the water and low away from it. The main aim of this study is to investigate overgrazing effects on acceptability of fodder plants along a grazing gradient around three natural watering points. To achieve this goal, we classified spontaneous plants according to their acceptability degree and we followed their cover, richness and density as well as the grazing value along a grazing gradient around these wells, using phyto-ecological studies during the spring 2004 and 2006. Main results show that very palatable plants (mainly constituted by annuals) are more dominant in both the closed and the more disturbed transect areas around wells. The unpalatable plants dominate sites with moderate disturbance around wells. Ligneous palatable species obviously have a lower degree of disturbance. During the studied seasons the grazing gradient around wells 1 and 2, the oldest ones, seemed to exert a feedback upon the grazing intensity.

1. Introduction

Grazing activity is among the spatially most relevant land use forms in southern Tunisia where annual rainfall is less than 200 mm/year. Hence water and fodder availability become limiting for both plants and herbivores, resulting in regular losses of herds in droughts and rendering livestock a driven rather than driving variable in the system. This situation, so-called non-equilibrium conditions, also known as "New Rangeland Ecology", is expected to occur under dry climates with a high coefficient of variance in precipitation (typically $>30\%$ and about 57% in our case) (Gillson and Hoffman, 2007; Sullivan and Rohde, 2002; Vetter, 2005). In time of drought natural vegetation becomes scarce and insufficient, animals need feed complement and the livestock access to key resources is limited to water (Milchunas and Lauenroth, 1993). Such situation buffers their populations against collapses and allows them to exert a relatively high continuous grazing pressure. It triggers by this way degradation around watering points.

Gradients of grazing over increasing distances from watering points have been used extensively in rangeland research to look at the impact of livestock on rangeland vegetation (Kinloch and Friedel, 2005a, b; Tarhouni, 2008; Tarhouni et al., 2006, 2007; Thrash, 2000). Distance from water can be used as a surrogate of grazing pressure – high near water and low away from water (Ludwig et al., 2001). The zone of extreme degradation surrounding wells is designed "sacrifice zone" by Graetz and Ludwig (1978). It is also called "piosphere" according to several authors (Andrew, 1988; Craig et al., 1999; Lange, 1969; Thrash, 1998, 2000). Tongway et al. (2003) revealed significant change in resources distribution processes at different grazing intensities and show that the "piosphere" effect is discernible even on a radius of 1–3 km from water. It was shown that the "piosphere" extend is more remarkable on sandy substratum as compared to stony one (Tarhouni, 2008; Tarhouni et al., 2007).

There are numerous studies dealing with the effects of grazing activity on vegetation cover, composition, distribution and floristic diversity (Abdallah et al., 2008; Jauffret and Lavorel, 2003; Jauffret and Visser, 2003; Mahamane and Mahamane, 2005; Savadogo et al., 2009; Tarhouni et al., 2006). Grazing affects the ecological balance as animals make a consumption choice that favours non-consumed plants and decreases the appreciated ones (Boudet, 1984; Waechter, 1982). However, Feoli et al. (2002) reported that grazing activity influences the vegetation physiognomy more than its composition. Changes in vegetation along a grazing gradient can be defined as a decrease in the perennial palatable plants and the dominance of unpalatable or

Abbreviations: CP, palatable cover; CUP, unpalatable cover; CVP, very palatable cover; DP, palatable density; DUP, unpalatable density; DVP, very palatable density; GV, grazing value; Is, acceptability index; PC, principal component; PCA, principal component analysis; RP, palatable richness; RT, total richness; RUP, unpalatable richness; RVP, very palatable richness; SFP, frequency of species presence; TVC, total vegetation cover; UP, unpalatable plants; VC, vegetation cover; VP, very palatable plants

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annual plants in the vicinity of wells (Heshmatti et al., 2002; Tarhouni et al., 2007; Todd, 2006). Likely, Geerken and Ilaiwi (2004) showed a decrease of perennial recovery, an increased mortality of woody plants and their replacement by less productive species under overgrazing. Concerning herbaceous plants, Soltero et al. (1989), Fusco et al. (1995) and Thrash (2000) concluded that these plants are more sensible to grazing activities around water. Their biomass is significantly reduced in the first 300 m from wells and their cover increases with greater distances. Same results are given by Metzger et al. (2005) and Tarhouni et al. (2007) confirming the fact that final degradation stages are mainly characterised by the abundance of annual plants. According to Craig et al. (1999), three changes in vegetation surrounding watering points can be easily remarkable: (i) development of an extremely degraded zone (until 55 m from water) where the soil is unstructured, erosion is intensive and the unpalatable and annual species are dominant, (ii) dominance of the unpalatable woody perennial plants beyond the zone of extreme degradation and (iii) less abundance of the palatable herbaceous perennial under selective grazing. These changes are due to the trampling effects in the ultimate surroundings of wells (first 50 m), the trampling and grazing effects beyond the zone of extreme degradation and finally the selective grazing impact (Ellis and Swift, 1988; Fernandez-Gimenez and Allen-Diaz, 1999; Stumpp et al., 2005).

In this context our study is integrated. Aims are to show that high stocking rates and the problems which come along with overgrazing loss fodder plant species. To achieve this goal it is important to evaluate the influence of grazing gradient on the cover, the richness and the density of unpalatable, palatable and very palatable plants and to investigate overgrazing effects on the grazing value around three watering points located in El Ouara communal rangeland which presents a great national and international importance (economic, social, nature conservation, etc.).

2. Material and methods

2.1. Studied zone

El Ouara region is a part of Presaharian Tunisia in the sense of Floret and Pontanier (1982), which corresponds roughly with the Tunisian part of the lower arid zone of North Africa, comprised between the isohyets of 100 and 200 mm of annual rainfall (Fig. 1).

Rainfall pattern and temperature regime in El Ouara are Mediterranean. The annual rainfall recorded in Sidi Toui national park, located in this region, during the period from 2001 to 2008 is represented in Fig. 2. The inter-annual variations of precipitation are very clear during this period (the coefficient of variance in precipitation is about 57%). The main land use in the region is livestock grazing. The vegetation can be characterized as a dwarf shrubland with some perennial grasses.

Three watering points and their surroundings, situated in El Ouara communal rangeland and visited by many animal species (camels, goats and sheep), were investigated in this study (Fig. 1). These wells differ by the duration of exploitation, their geographical locations and the nature of surrounding vegetation. The first watering point (well 1, exploited for 150 years) is located in the North of the studied zone, the second (well 2, exploited for 100 years) and the third (well 3, exploited for 10 years) are situated in the south. Well 1 is located on a stony soil with truncated top layer and surfacing rock due to erosion and the plants around it are dominated by *Anthyllis sericea* Lag. subsp. *henoniana* (Coss.) Maire and *Gymnocarpos decander* Forssk. The east of this watering point is occupied by *Stipagrostis pungens* (Desf.) de Winter and *Hammada schmittiana* (Pomel) Iljin. Wells 2 and 3 are situated on a sandy substratum and surrounded by *S. pungens* and *H. schmittiana*. In time of drought natural vegetation around wells becomes scarce under strong animal activities when accessing to water.

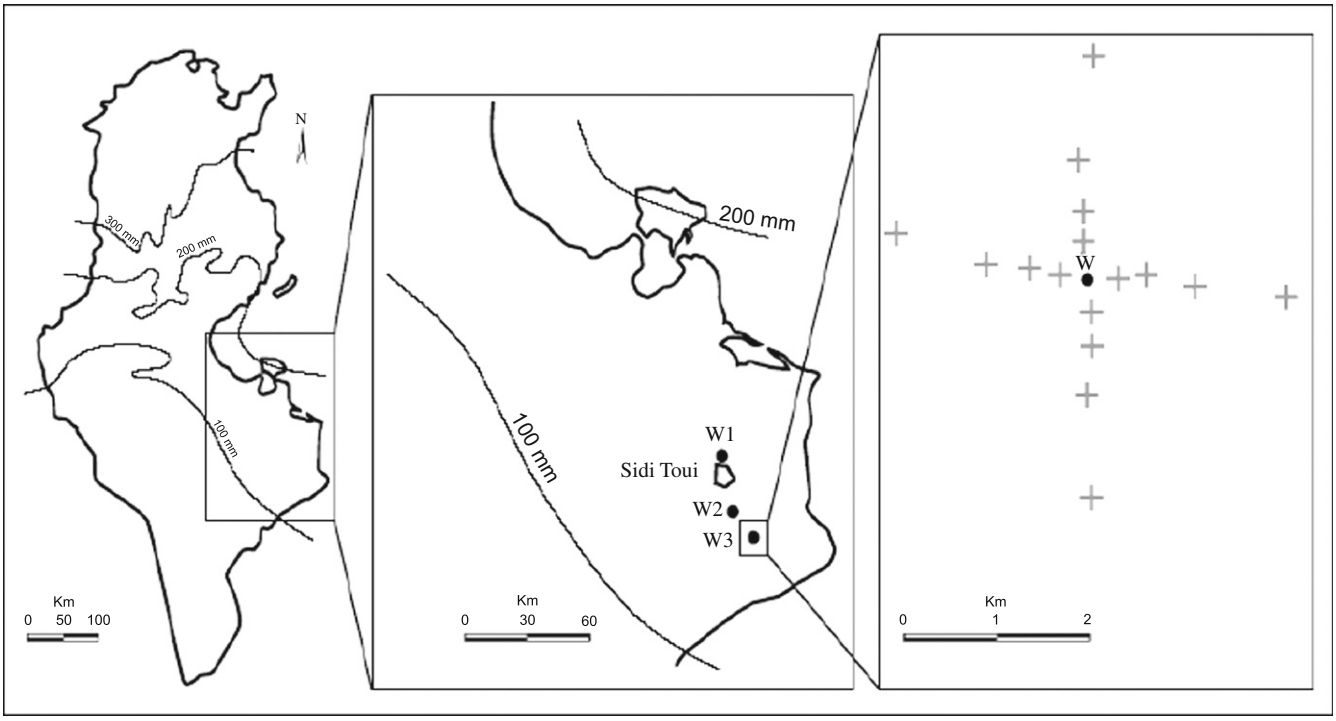

Fig. 1. Location of the three studied watering points (W1=Well 1; W2=Well 2; W3=Well 3), Sidi Toui national park, and the sampling design around each well.