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INFLUENCE OF MECHANICAL COPPICING ON THE BIOMETRY AND BIOMASS OF PASTORAL PLANTATIONS OF *ATRIPLEX CANESCENS*: A CASE STUDY OF RESTORED RANGELANDS IN THE DJELFA REGION, ALGERIA.

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Abstract

Topic description: The aging of *Atriplex canescens* plantations requires development, to better satisfy the food needs of the sheep herd on steppe rangelands.

Objectives: The aim of the study was to replace animal grazing with mechanical pruning to improve biomass production and to show to what extent cutting levels influence the behavior and regeneration dynamics of plants.

Methods : Three experimental stations (S_1, S_2, and S_3) they are located respectively on a sandy substratum (dune) with a very low biomass, a salty soil and a soil of an old forest. In plots of one hectare with a density of 1000 plants/hectare, mechanical cuts were carried out on shrubs at different heights (H_{10}, H_{30} and H_{50} cm) during a follow-up period of 05 years (before pruning A_0 and after pruning A_1, A_2, A_3 and A_4).

Results : The results obtained reflect the influence of the factors studied (substrate, age, and cutting level) on the biometric parameters (height and girth) of the clumps. For S_1, whose age exceeds 25 years, the plants have already been transformed for the most part into wood with very low fresh material rates. The substrate and age were unfavorable to the development of the plant; the three levels of cutting had only a derisory effect, especially for H_{50}.On the other hand for the two other stations S_2 and S_3 younger. The influence of cutting levels shows better results for H_{10} and $H_{30,}$ where there is a significant presence of grassland.

Conclusion : In view of the results obtained, it would be desirable to opt for a judicious generalization of mechanical pruning in *A. canescens* plantations with cuts at H_{10} and H_{30} from the ground level to increase the biomass yield and the longevity of the plantations.

Keywords : *A.canescens;* Pastoral management*; B*iomass;Biometry; Djelfa;Steppe rangelands; Plantation; Re-cutting; Over exploitation.

INFLUENCE DU RECÉPAGE MÉCANIQUE SUR LA BIOMÉTRIE ET LA BIOMASSE DES PLANTATIONS PASTORALES D'*ATRIPLEXCANESCENS :* CAS DES PARCOURS RESTAURÉS DE LA RÉGION DE DJELFA, ALGÉRIE

Résumé

Description du sujet : Le vieillissement des plantations *d'Atriplex canescens* nécessite un aménagement, pour une meilleure satisfaction en besoins alimentaires du cheptel ovin sur parcours steppiques.

Objectifs : Le but de l'étude a été de substituer le pacage animal par un recépage mécanique afin d'améliorer la production de la biomasse et de montrer à quel point les niveaux de coupes influencent le comportement et la dynamique de régénération des plantes.

Méthodes : Trois stations (S_1, S_2 et S_3) situées respectivement sur un substrat sableux (dune) avec une très faible biomasse, un sol salé et un sol d'une ancienne forêt. Dans des placettes d'un hectare avec une densité de 1000 pieds/hectare, des coupes mécaniques ont été effectuées sur des arbustes à différentes hauteurs (H_{10}, H_{30} et H_{50} cm) durant une période de suivi de 05 années (avant recépage A_0 et après recépage A_1, A_2, A_3 et A_4).

Résultats : Les résultats obtenus reflètent bien l'influence des facteurs étudiés (substrat, âge et niveau de coupe) sur les paramètres biométriques (hauteurs et circonférences) des touffes. Pour la S_1 dont l'âge dépasse les 25 ans, les plantes se sont déjà transformées pour la plupart en bois avec de très faibles taux des matières fraiches. Où le substrat et l'âge ont été défavorables pour le développement de la plante, les trois niveaux de coupe n'ont eu qu'un effet dérisoire et surtout pour H_{50}. Par contre, pour les deux autres stations S_2 et S_3 plus jeunes. L'influence des niveaux de coupes enregistre de meilleurs résultats pour H_{10} et $H_{30,}$ on assiste donc à une présence importante d'herbages.

Conclusion : Au vu des résultats obtenus, il serait souhaitable d'opter pour une généralisation judicieuse du recépage mécanique dans les plantations d'*A. canescens* avec des coupes à H_{10} et H_{30} du ras du sol afin d'augmenter le rendement de la biomasse et la longévité des plantations.

Mots clés : *A. canescens;* Aménagement pastoral; Biomasse; Biométrie; Djelfa; Parcours steppiques; Plantation; Recépage; Surexploitation.

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INTRODUCTION

The immense steppe territory estimated at 21 million hectares corresponds to 9% of the total area in Algeria [1]. From East to West, this ecosystem is marked by a very particular ecological and landscape dynamics from the point of view of floristic richness and diversification of vegetation strata. Quoted by various authorsAuthor [2] and author [3], it belongsto the arid and semi-arid bioclimatic stageswhere dominate the *poaceae, asteraceae, chenopodiaceae* and *zygophyllaceae* dominate. These natural environments, composed mainly of rangelands mostly degraded [1], are currently exposed to several forms of deterioration that lead to a spatio-temporal desertification and a degradation of their ecological landscapes, which is reflected in the weakening of natural resources (animal and plant) that make uptheir biotope.

"Despite the importance and consideration of the potentialities recognized to this environment, the multiplication of development programsremains for the most part insufficient and unworkable.By undergoing natural and anthropic phenomena, leading to a very accentuated degradation of natural environments. The analysis of the various modes of exploitation of the pastoral space leads to unsatisfactory results of the systems of productions using the courses in various degrees "[4].

Thus, what the authorsAuteurs [5]" consider that the characterization of pastoral pressure represents one of the main issues in terms of ecology and management of rangelands, for extensive sheep farming" According to Author [6]," Several major stages of degradation must be considered before reaching a threshold of irreversibility for the biomass, vegetation composition and reproduction of this natural environment. The optimization of natural resources of steppe ecosystems had as main objective the restoration and rehabilitation by pastoral plantations, of degraded environments, nevertheless this development must be reoriented, towards a better strategy of adaptation of pastoral potentialities, ecologically sustainable, economically profitable and socially acceptable. According to the author [4], "the current state of the rangelands and the prospects for development are in tune with the launch of projects to rehabilitate steppe environments in order to catch up. Le Houérou (1980) proposed some means of fighting against this phenomenon: "-planting of fodder species; the setting of defenses; creation of rural woodlands and windbreaks; fixing the dunes; definition and implementation of pastoral policies and land use" [7].

"Faced with the threat of the disappearance of these natural spaces, scientists agree on the need to study and protect them. Their protection does not consist of putting them "under the bell", but consists of maintaining or restoring a mode of appropriate management" [8]**.** For more than two decades, Algerian authorities have raised the challenge, which was aimed at a positive rehabilitation of fragile environments, by fodder plants, the genus *Atriplex*. "Generally speaking, restoration projects related to the fight against desertification consist of reintroducing plants that are resistant to high levels of salinity, drought,and grazing pressure. To restore the situation and rehabilitate the environments affected by drought and aridity of the climate, some exotic species introduced in Algeria since the 1980s have shown their ability to adapt to the eco-edaphic and climatic requirements of the steppe. The plantations in the steppe environments have affected more than, 320,000 ha included 37,000 ha of pastoral plantations"[9]. "The priority of action lies in a very ambitious program launched since 1994 by the Algerian authorities at the charge of the H.C.D.S. Entitled "Great Works for the Development of Steppe Pastures», it covers more than 900,000 ha of pastoral plantations in 22 wilayas. Its main focus was the *Atriplex* plantation and in particular the species *canescens*" [10]. For this purpose, perimeters of *Atriplex canescens* were created to improve the fodder supply of livestock and to succeed in the very costly plantations. Despiteof the efforts made and the means implemented, the capacities used so far have not shown significant effects. The clumps of *Atriplex* are aging more and more, hence the progressive drying up of the green parts of the plants, which is becoming more and more worrying. In this context, our work is integrated, the objective of which is the rational exploitation of restored steppe rangelands and the appreciation of the resilience capacity of selected plant species (*Atriplex canescens*). The choice of the recutting method aims at the sustainability of the plant resources and the possibility of recovering the formerly planted perimeters through the steppe. This was achieved by applying cuts at several levels of the plant.

Therefore, after five years of monitoring and observations, the results obtained showed a clear optimization of the quantities of plant mass. This resulted in the preservation of the growth energy of the different parts of the plant anda maximum stabilization of the palatable dry matter rates by increasing of the nutrient content. This has resulted in better satisfaction of the food needs of the sheep herd on pasture, estimated at more than 25 million head nationwide [11].

MATERIELS ET METHODES

1.Presentation of the study area

1.1. Geographical location

With altitudes often exceeding 1000m, the study area is an integral part of the steppe ecosystem whose geographical limits are defined by bioclimatic criteria alone. It is limited to the north by the 400 mm isohyet which marks the beginning of cereal zonesand to the south by the 100 mm isohyet,indicating the beginning of the Saharan domain [3]. The experimentation took place in the North-West of the wilaya of Djelfa on three perimeters of *Atriplex canescens* plantations in the localities of "Hliti, Rocher de Sel and El Harcha" located respectively in the communes of Zaafrane, Aïn Maabed and El Guedid (Fig. 1)

These are old perimeters among the pilot communes that have hosted pastoral plantation projects in order to provide reliable solutions to the problem of fodder, the increase in the rate of lignification of *Atriplex* and the worsening of desertification. The age of the plantations differed according to the dates of the projects (Table 1) on the most degraded rangelands affected by desertification.

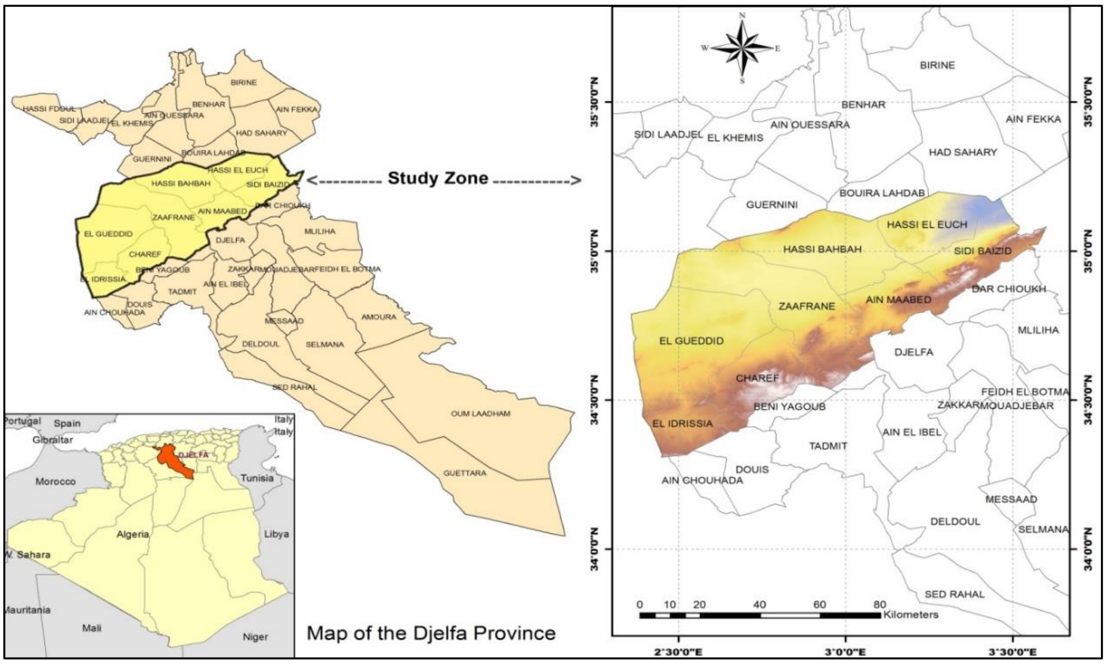


Figure 1: Map of study zone

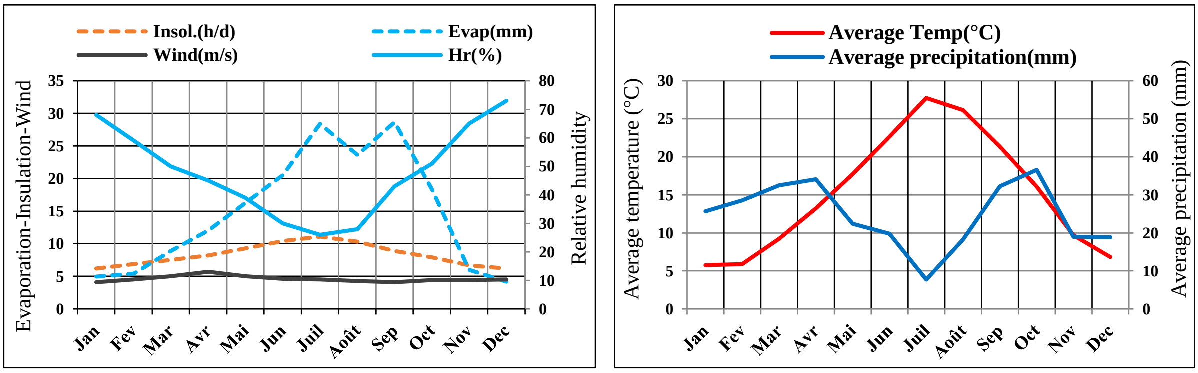
Table 1: Characteristics of the experimental stations

Data / Station	Station S_1	Station S_2	Station S_3
Contact details	34°49'40'' N 02°55'40'' E	34°53'04'' N 03°03'56'' E	34°39'12'' N 02°22'36'' E
Location	H'liti	Salt Rock	El Harcha
Year of planting	1994	2001	2009
Area (ha)	230	220	870
Density (plants/ha)	1000	1000	1000
Nature of the substrate	Dune	Saltysoil	Old forestfloor
Slope (%)	1	2,6	12,8
Degree of course degradation	High	Medium	Medium

1.2. Pedoclimaticoverview

Mostly on limestone substrates, the soils are shallow, skeletal, with high salinity, poor in organic matter and mineral elements and very sensitive to any form of degradation, especially to wind erosion [12]. They do not favor the development of any plant cover except the typical steppe vegetation.

According to the analysis of data provided by the National Office of Meteorology of Djelfa[13], the study area is located on a semi-arid bioclimatic stage of Mediterranean type. It is characterized by a long dry and hot summer season and a cold and rainy winter season (Fig. 2).



Climatic parameters of the Djelfa region **Umbrothermal diagram of Bagnouls & Gaussen**

Figure 2: Evolution of climatic parameters in the region of Djelfa (O. N. M, 1991-2018)

In steppe environments, rainfall is low and extremely variable,and daily or seasonal thermal amplitudes are very important. Despite these limitations, species of the genus *Atriplex* planted in this environment manage to develop and give excellent results. The evolution of the climate and the socio-economic, changes risk to compromise in an irreversible way all thepotentialities in natural resources. The steppe remains the only natural barrier against desertification [39]. In the same opinion and according to [14], "overgrazing is not the only agent of deterioration of the steppe environment and that livestock is not the only or the most important factor of desertification. On the other hand, the irregularity of rainfall on the one hand and the collection of firewood and brush, on the other,are all the more serious."

1.3 Land use

Strictly steppe vegetation is now confined to skeletal soils, highly saline terrain and dunes [15]. The importance of steppe rangelands in the study area is due to its pastoral vocation par excellence, the vastness of the territory and the useful agricultural area (Table 2).

According to the study conducted by [16], the results show an advanced level of degradation of the rangelands that occupy most of the Algerian steppe (Fig. 3) and more particularly in the West and Center around the saline and sandy areas. The *Atriplex* occupies the majority of plantations carried out on the steppe rangelands with areas approaching one million hectares [1].

Table 2: Land occupation in the wilaya of Djelfa (2017/2018)

Area	**STW**	Compared to STW			Compared to the SAT	
		Forest	**Uneducated**	**SAT**	**UAA**	**Course**
Ha	3 225 635	559 738	164 804	2 501 093	378 665	2 122 428
%	100	17,35	5,11	77,54	15,14	84,86

STW: Wilaya Total Area, **SAT**: Total Agricultural Area, **SAU**: Useful Agricultural Area

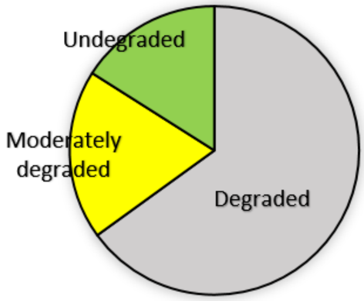


Figure 3: Status of steppe rangelands in Algeria (HCDS, 2018).

1.4. *Plant material*

According to [2], *Atriplex spp* is one of the more or less rare species that has an economic interest and potential for the rehabilitation of degraded areas. The species *canescens* was introduced in Algeria as an experiment in the early 80s [17] in the framework of the project of biological fixation of dunes (the dune cordon of El Mosrane in the steppe region of Djelfa). This exogenous plant, originally from North America, currently occupies the largest part of the planted areas in the entire Algerian steppe. Belonging to the *Amaranthaceae* family, it has proven its potential for restoring degraded steppe environments. With a good value of feed, it is very appreciated by sheep. This suggests that the choice of this species has been largely justified. It should be noted that the shrub *A. canescens* is the only plant material used in our experiment.

Due to its great capacity to resistdrought, rooting, and improvement of the physico-chemical properties of the soil by the contribution of organic substances, the *Atriplex* had beneficial effects on the environment, biodiversity, vegetation cover, and the rehabilitation of the productivity of the steppe ecosystem [18].

2. *Methodology of approach*

The experimental approach adopted aims toanalyze the behavioral mechanisms of *Atriplex canescens* and its development of physiological growth after mechanical pruning in order to provide a decision-making tool for its application.

The present study therefore focuses on the possibility of replacing animal grazing by a mechanical recutting technique applied for the first time on *A. canescens* plantations in the Djelfa region. The objective is to see its influence on the improvement of the biometry of the plant inducing the aerial phytomass and the fodder contribution of the course. During five years of experimentation at three sites (perimeters), a permanent annual monitoring of the development and growth of *A. canescens* shrubs was carried out to study the influence of 3 factors "***Substrate, Cutting*** and ***Age***" on the two main biometric parameters of the plant: ***Height*** and ***Circumference*** of the tufts. In each planted area, a plot of 1 hadbeen delimited with an average density of 1000 plants/ha per station (2.5m on 40 lines) and (4 m on 25 columns) all equidistant.

During 04 years, the recutting of *A. canescens* plants was carried out by alternating strips at 03 cutting levels (H_{10}, H_{30} and H_{50}cm), on the 3rd, 6th, 9th, ..., 36th feet of each line corresponding to the 1st, 4th, 7th, ..., 25th feet of each column.

A total of 108 feet were recutper plot, equivalent to 36 feet for the 3 levels of cutting. It should be noted that in each experimental station and for reasons of non-waste and preservation of the plantations, feet were left intact and served as a control. The cuts were made mechanically on the same day at the 03 stations using a motorized chainsaw for the old (hard) stems and pruning shears for the young shoots.

To evaluate the effectiveness of the technique used and to characterize the green production according to the structure of the shrub, it was necessary to first have measurements of this production which can be evaluated from the number of its branches, their height and their diameter [19].

The plant in question is a halophyte shrub that is very well adapted to steppe environments and whose clump can reach a height of 03 m [20]. The technique used consists in cutting at ground level at 03 levels (H_{10}, H_{30} and H_{50} cm) all the aerial part which corresponds to the epigeous biomass sought by the animals during grazing [21]. Other measures remain important, especially in the presence of the animal, which has always had a stimulating effect on the dynamics of the vegetation (new growth and denser foliage). This presence is essential because it induces in the grazed species a phenomenon of stimulation and reconstitution of organized and rational pastures. In this respect, the choice of the bromatological analysis technique adopted in our work was based on the evaluation method cited by [22]. This involves the sampling of a few individuals per plot while leaving the others standing. This direct and semi-destructive method remains rigorous and precise because it is often used for its speed and lower cost. Based on simple external measurements (height and diameter), it consists of cutting a few individuals from vegetation in the sample plot at certain levels to estimate the phytomass of shrubs and evaluate biovolume [23].

The experimental set-up adopted is completely random with 03 factors considered as qualitative parameters, "***Substrate***, ***Cut and Duration***". The first is represented by 03 substrates (S_1, S_2, S_3), the second by 03 levels of cutting (H_{10}, H_{30} and H_{50}), and the third by 05 years of measurements (before cutting A_0, after cutting A_1, A_2, A_3 and A_4). The choice of the 03 stations was determined according to the substrate where each station is located in a different biotope with a different date of launching the project, determining the age and homogeneity of the vegetation. Biometric measurements (height and girth) were taken from samples taken before and after pruning at different levels on alternating strips in the interior. The principle of calculation of the biomass is based on the dry matter content of the plant before and after pruning. The sampling is limited to a few subjects at rate of one foot for each line on a surface of $10m^2$ /foot = (2,5 m x 04 m). At the end of our experiment, our results were statistically processed (ANOVA) to highlight certain links between the explanatory variables and the degradation of the steppe rangelands, on the one hand, and on the other hand, to discover the interactions between the different variables, to better appreciate the effects of the cutting levels of *A. canescens* on the biometric properties of the phytomass. For this purpose, we used Statistica 10.0 software (Stat Soft Inc., 2011).

DISCUSSIONS

1. Impact of pruning on plant development

1.1. Impacts on clump height

At station S_1, the results obtained showed that the heights of the clumps remain relatively low compared to their initial forms (before cutting) considered as a control and where their average is close to 1 m (Fig. 5). They are practically lower for the cutting level H_{10} as

well as for H_{30} and H_{50} where the values do not exceed those of the controls. This remains true even after the fourth year of observation, perhaps because this perimeter has not found its dynamics of vegetative recovery and its regeneration has become almost impossible. More than 20 years old at the time of the beginning of our study, the perimeter has remained unused and unmaintained, leading to its degradation. At present, it is totally abandoned and exposed to different forms of alteration, which has led to its neglect by herders and their livestock.

In the other two stations S_2 and S_3, there is a significant increase in the height of the control feet which exceeds 01 m and 02 m respectively for S_2 and S_3.

Less than a year and a few months after the cuts were made, there was a drop in the values recorded for the two levels H_{10} and H_{30} in contrast to the level H_{50} where the growth rate is long and the clumps are mostly lignified. But from the first year of plant growth, the heights are almost the same as those of the control.This shows a good recovery of the shrubs following an increasing trend from one year to another to arrive at the end of the fourth year of observation at its maximum of development at more than 2 m high measured for H_{30} and H_{50} cm and similarly for the H_{10} level which is close to 2 m in the majority green. However, the general remark drawn for S_2 and during a period of 12 months, this height is multiplied by 8 to 10 times for the level H_{10} and 14 to 15 times for the other levels H_{30} and H_{50} (Fig. 5).

Following the same increasing trend of the height of the clumps from one year to another, it appears that there is a good growth for this station.To maintain the high biodiversity of semi-natural grasslands, management by grazing or mowing is needed**[28].**

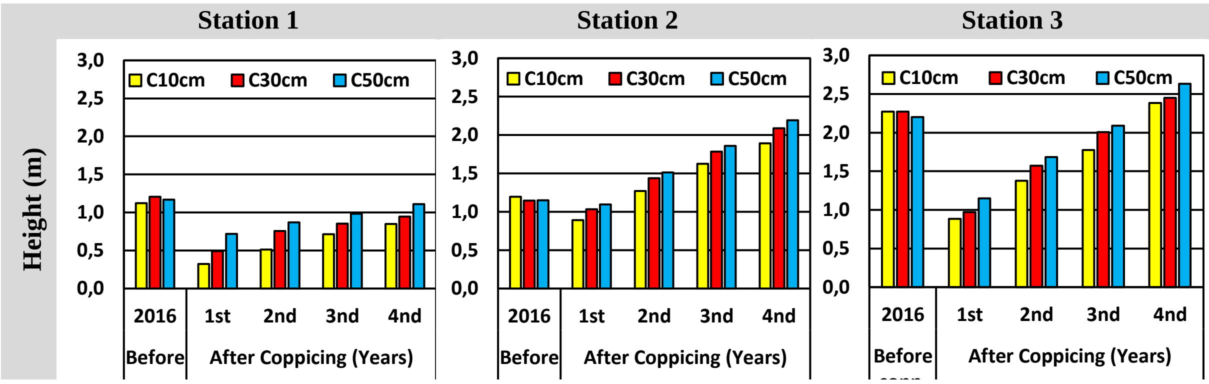


Figure 5: Average height of *A. canescens clumps* before and after pruning at three levels of cutting for the three study stations (during five years of monitoring

This means that the cuts have a direct effect on the organs of the shrubs which are not completely aged and lignified, like those of S_1, which show a significant delay in growth. For control subjects, they are very well developed from the point of view of the phytomass prior to cutting. The heights recorded indicate a significant growth of the plants, the average of which exceeded 02 meters, and therefore it is considered that this is the optimum for consumption by the animals in free grazing. Otherwise, cuts will be made to prepare the feed composed of foliage, twigs and green shoots, which will be presented to the animals in the stall in the form of green feed or dried after sorting out the lignified twigs, which will be used as fuel or for other craft purposes.

Applying the recutting in station 3, it was noticed that from the first year a considerable drop in height values was recorded. Composed mainly of green phytomass at a few months and less than a year, the recorded heights reach on average 0.9m to 2.1m. To this end, the best size considered not too lignified presents a considerable interest of palatability. The appreciable particles of the plant are consumed to maximum by the sheep. In the three cutting levels H_{10}, H_{30}, and H_{50} cm (Fig. 5), the growth rate gradually increases from the first year to the third year. This perimeter is considered ideal for its biomass composition, a suitable age of grazing and maximum energy of regeneration with plant offshoots.This is consistent with the literature that considers that at the third-year one can apply the cuts on shrubs.If otherwise, one exceeds the third year until the fifth year of age of the plants, considered propitious and considered to be the peak of grazing, the quantities of phytomass are maximum and the clumps are still important.Beyond the fifth year, the risk of lignification is considerable and the animals will no longer have access to the leaves, green shoots and twigs.If the duration is close to 10 years and the plantations will not be grazed or re-grazed, the wood content will be important. In such a situation, the heights will be at their maximum growth and it would therefore be preferable for the competent authorities to leave these large areas planted with *Atriplex* open and accessible to livestock. It is imperative to respect the equilibrium animal load allowed during the release of the animals or, failing that, to carry out recutting for a possible regeneration of the plants.

1.2. Impacts on clump circumference

In contrast to other *Atriplex* species, the height and circumference of *A. canescens* clumps develop relatively at the same rate of growth simultaneously.

The results show a slowdown in the old perimeter corresponding to station S_1 and those for the three levels of cuttings where growth rates in circumference hardly exceed those before recutting (Fig. 6) indicating significant lignification.It is noted here that recutting is without effect.

However, both stations S_2 and S_3 recorded an appreciable increase in girth that exceeded 2.5 m on average for S_2 for the cutting levels in the third year of observation, and almost 3 m in the fourth year.In S_3, with regard to cutting H_{50}, the girth exceeds 3 m from the first year (Fig.6). The importance of the growth of the circumference in S_3 can be explained by the quantities of fodder produced, with the extraction of the phytomass which is totally appreciable by the animals on the courses.In this perimeter, it is also necessary to add the optimal age of the shrubs, while maintaining a balance between the green (rich in nitrogen) and the wood (rich in carbon), in order to allow a regenerative dynamic and a more sustainable exploitation, before reaching a threshold of aging, as in S_1 where the limit of the growth of the diameter is 01m.For S_2 and S_3 , after five years of observation the data collected on the circumference are respectively 03 m and 04 m in average (Fig. 6).These two values are close to those before recutting, except that the lignification is significantly lower than before the cuts.According to[24]. "The estimated height and biovolume for each shrub age class showed an increase between 5 and 10 years. Within each age class. The case of stations2 and3. While the ratio (height) / (average radius) circumference= (2(π) rayon) which implies ($C=2\pi r$), decreased with the life stage

of the plants which decreases in relation to the age of 15 years. This coincides with the parameters found in the ancient shrubs of station 2, parametersheight and girth.

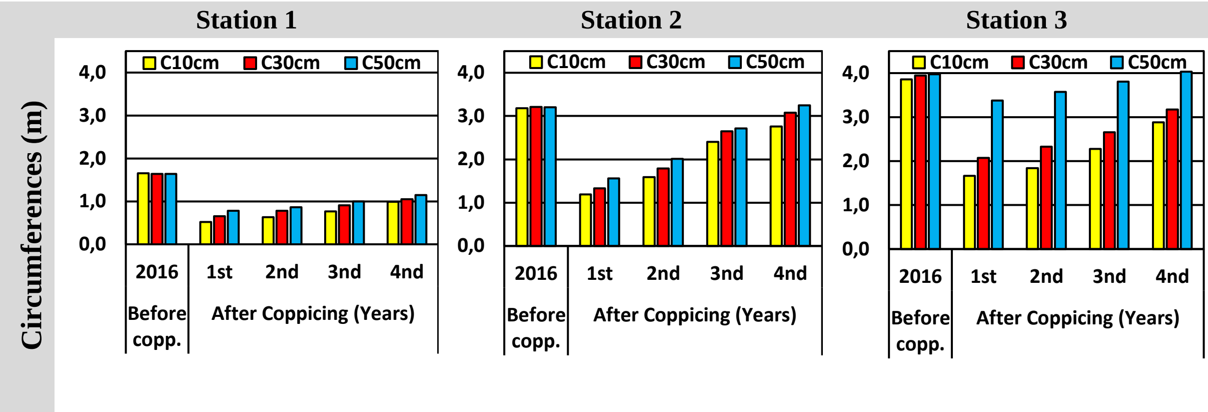


Figure 6: Average circumferences of *A. canescens* clumps before and after re-cutting at three levels of cutting for the 03 study stations (during 05 years of monitoring)

1.3. Impacts on phytomass(green part)

Stations S_2 and S_3, the aboveground phytomass remains relatively high for the shrubs cut back at H_{10} and H_{30}, a little less so for the cutting level H_{50}. On the other hand, station S_1 is clearly inferior with very low rates and an average of the three cuts almost negligible with 28% of fresh and green matter.After five years of monitoring, the high values recorded are those of cutting H_{10}at S_2 and S_3 with 66.25%and 78.8% respectively. These values are considered important, especially since the stages of lignification are insignificant during the four years following the first year of cutting. There is a direct influence of pruning on shrub regeneration. From our field observations and results (Fig.7), the main finding is that clumps differ markedly in physiognomy, especially those not pruned. Compared to those subjected to cuts which are more green with a high dominance of leaves, to the detriment of stems and semi-lignified stems. This confirms the results cited by Author [25]where the aboveground biomass of shrubs in the fourth year is about three times higher than in the first year.

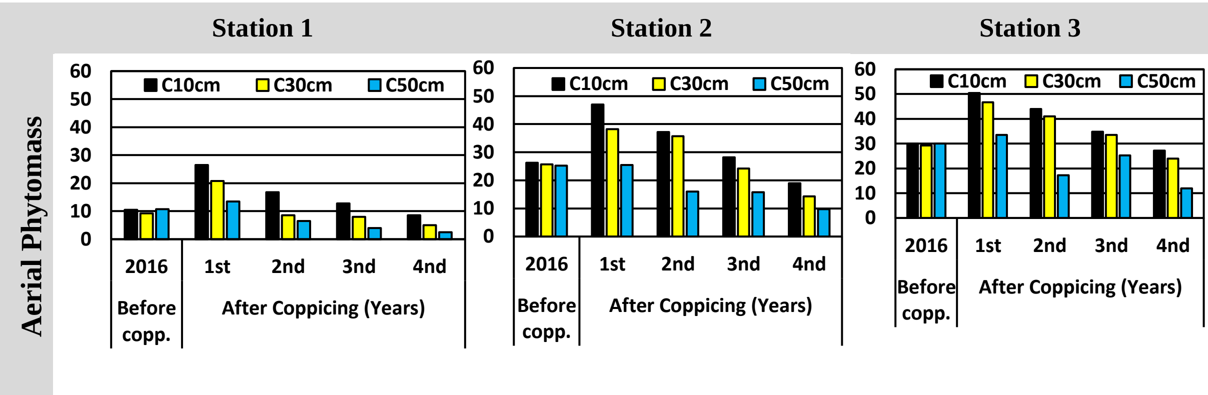


Figure 7: Evolution of the number of green shoots of *A. canescens* before and after re-cutting for the 03 stations

This increase is recorded in the first year only, and then the following year there is a drop in the weights of the fresh material, which may be due to the increased drying of the leaves and green shoots, which become increasingly yellowish and dry. The fall of the green parts of the plant is generally caused by the action of the local winds and the rain showers.

Planted mainly for their double interest (erosion control and as a fodder resource) [1], the clumps of *A. canescens* play a protective role in the stations S_2 and S_3 (windbreaks). This genus is also added to be significant for its ability to improve poor soils by creating a vegetation cover around the shrubs and reducing the level of salts in the soil [26]. The results obtained reveal that the percentage varies according to the organs of the species, the levels of cuts and the age of the plants subjected to the recutting giving a prolonged longevity of the woody species. To reduce the risk of fire in fully lignified trees, avoid letting branches become wood for less than a year. Maintaining the plant's skeleton (stem and branches) will allow more buds to burst and green shoots and leaves to emerge, giving all components of the plant a chance to regenerate and become fresher, softer and more usable by animals in the next rotation. In addition, we leave an appropriate time for the physiology of development of the plant to grow in balance (green part and lignified part) for a potential food use of reference. Therefore, it would be important to substitute machine harvesting (chainsaw) with the level of pacagert while avoiding to the maximum the deterioration of the different organs of the plant and maintaining an optimum of fodder offer of all the parts of the plant (green shoots, seeds, sprigs and twigs). It is possible to drive the animals for a few days in these courses with multiple passages in order to exploit the green part of the plant while leaving the hard parts to be recut. According to the results obtained by[27], *Atriplex*has a high biomass after 25 years in grazed and excluded areas. Periodic natural grazing is recommended for maintenance and good green growth of plants. Access to the perimeters should be allowed every 4 years while avoiding leaving them fenced off without being exploited. Under these conditions, age has no effect unless animals are allowed to graze the restored rangeland as appropriate and according to the ecological health of the rangeland and its biodiversity. As mentioned in numerous studies that show positive results of grazing on diversity [28]. The efficiency of livestock production in shortgrass rangelands can be increased by grazing rangelands dominated by "four-winged saltbush" (*A. canescens Pursh Nutt*) [29]. However, the ecological role of *Atriplex* plants *in* these managed rangelands is effective following the presence of significant amounts of biomass from the permanent parts of the crown. It can also have useful effects in controlling erosion and modifying the microclimate of the region (shade, litter production, etc.) [18].The species *A. nummularia* is second in planting rates next to *A.canescens*, in the Algerian steppe. A. *nummularia* has atendency to grow too large. Pruning every 4-5 years to a height of 25 cm above the ground was positive in promoting the renewal of vegetation and preventing overgrowth. This favors woody tissue productionat the expense of leaf production and gives the plant a senescent appearance.Furthermore, with reference to these results, we found a similarity at the station S_3thatrepresents the optimal age of re-cuttingwith the ideal cutting level at H_{30}.

2. Results of the statistical analysis

2.1. ANOVA of shrub biometrics

At the end of the results of the ANOVA analysis, we notice with respect to the previous variables that the influence of the three factors studied (Substrate, Cup and Duration) is highly significant with a p-level almost zero (Table 2).

Table 2: Analysis of variance of the height and circumference of the clumps of the 03 stations studied

Station	NC	Height					Circumference				
		AND	*Var*	*Err-T*	*SEM*	*p*	*AND*	*Var*	*Err-T*	*SEM*	*p*
S1	H_{10}	0,29	0,08	0,04	0,01	**	0,41	0,17	0,05	0,01	**
	H_{30}	0,24	0,06	0,03	0,00	***	0,36	0,13	0,05	0,01	***
	H_{50}	0,17	0,03	0,02	0,00	***	0,33	0,11	0,04	0,01	***

	H_{10}	0,36	0,13	0,05	0,01	***	0,78	0,61	0,10	0,06	***
S2	**H_{30}**	0,41	0,17	0,05	0,01	***	0,79	0,62	0,10	0,08	***
	H_{50}	0,43	0,19	0,06	0,01	**	0,69	0,47	0,09	0,03	**
	H_{10}	0,57	0,32	0,07	0,00	**	0,82	0,67	0,11	0,02	**
S3	**H_{30}**	0,54	0,29	0,07	0,01	**	0,68	0,47	0,09	0,02	**
	H_{50}	0,51	0,26	0,07	0,00	***	0,27	0,07	0,03	0,01	***

N C: Cut level, ***SD***: Standard deviation, ***Var*** : Variance, ***Err T*** : T-error, ***SEM*** : Standard Error,***p***: Probability

Statistical analyzes of the data showed a wide range of values at each station, namely:

Station1: The variance is proportionally low between the three levels of cuts ranging from 0.08 at H_{10}, to 0.06 at H_{30} and 0.03 for H_{50}. It can be seen that the cuts have no influence especially at H_{50}andfor girth. As mentioned in Table 2, the variance values are 0.05 for H_{10} and H_{30} and 0.04 for H_{50}. The age factor showed a significant effect on the height and circumference of plants. The plants have not been able to regenerate due to aging and lignification with a high proportion in this station. Restoration or rejuvenation measures remain without effect. Grazing in this area is almost non-existent, except for a light passage for dromedaries in rare cases due to the quantity of wood that has invaded the clumps. Again, locals overuse the wood branches for various purposes, among others as fuel during a long period of cold that can reach up to 9 months in the steppe region of Djelfa where the temperature reaches the value of -10°C during some days of the winter. In the old plantations (station 1), the old subjects have reached an almost total lignification rate of 100%. These data can be supported by the words of [40],who confirm the rational use of the cut wood.The product of the pruning of the species *A. nummularia* represents therefore a remarkable energy resource.Indeed, the calorific value of the wood produced by *A. nummularia* is about 4.538,3kcal/kg. The efficiency of livestock production in shortgrass steppe may be increased by grazing four- wing saltbushes (*Atriplex canescens* [Pursh] Nutt)-dominated rangeland in late fall and/or early spring[29].

Also, from a quantitative point of view, the production of firewood can be considerable[30].

Station2: The analysis of variance showed interesting results for the cutting levels H_{30} and H_{50} with respectively a variance of 0.17 and 0.19 and a little less for the level H_{10} with only 0.13.These values show the impact of the factors studied on the height of the shrubs and the difference between the 3 levels is negligible.Contrary to the circumference, the factors age and cutting levels H_{10} and H_{30} have a direct influence on the plant and are exclusively the best for all stations. Obviously, the green parts will become strands and future semi-lignified branches. Therefore, those that were already semi-lignified will become more branches and stems that are harder and larger, giving a circular and rounded appearance to the clumps. These stems will support the green part of the crown of the plants. In this station S_2, the circumference recorded variance values of 0.61 for H_{10} and 0.62 for H_{30}. Unlike for the H_{50} level, it is proportionally lower with only0.47. This shows that the girth is influenced by all 3 factors (station, cut and duration) with$p=0.00$null.According to some works [31],efforts must also be multiplied by using other species and techniques that allow good conservation of biodiversity.

Station 3: For this station, the results presented in Table 2 indicate a higher variance value with respectively 0.32 for H_{10}, 0.29 for H_{30} and 0.26 at H_{50} proportionally lower. However, these results remain relatively the best compared to the other stations S_1 and S_2. On the other hand, the age of the clumps remains the most influential factor directly on the increase in height, particularly at H_{10} and H_{30}. This confirms that the cutting technique applied has excited the green part of the plant towards a much more vertical growth.

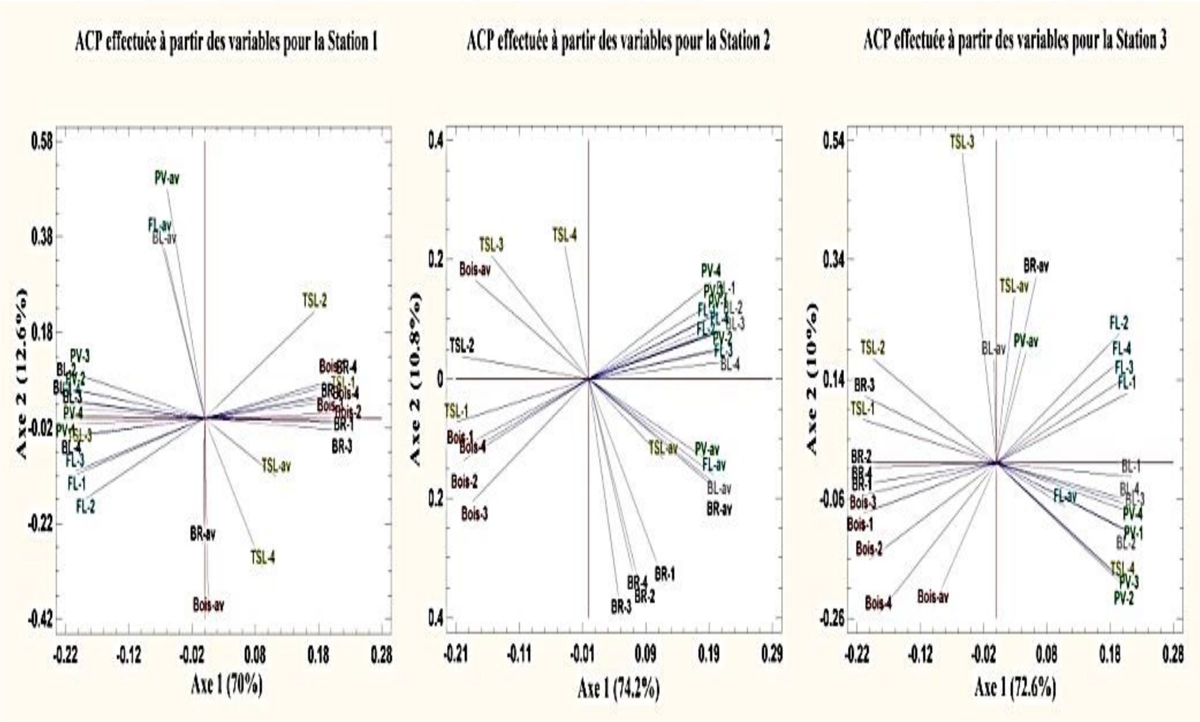
This height tendency is the result of the alternating recutting over the years. The emerging hard parts of the shrubs (branches and twigs) are simultaneously replaced by new branches, which in turn are converted into softer semi-lignified stems. One year later, these vegetative extensions are replaced by softer strands and twigs, which explains the high level of green aerial biomass, which is mainly composed of green shoots and leaves that emerge in search of light for photosynthesis.Contrary to the results concerning the circumference measurements, the values are proportionally lower compared to the stations S_2 and S_3. This can be explained by the fact that these shrubs are still young and their dynamics of recovery in circumference will take more time to form a semi-lignified crown. It will be composed mostly of hard branches falling horizontally around the plant. And, during the first years, the appearance of the feet will take a vertical tendency and a rate of covering exceeding 70 % of green/wood. According to some studies[32], biomass removal, trampling, and nutrient supply via animal droppings and plant restitution will shape the plant community by altering biotic and a biotic condition [41].

2.2. Principal Component Analysis (PCA) for Biomass

***Station 1*:** Principal component analysis places the samples in two groups according to the factorial plane (Axis1 x Axis2). The measured parameters show a significant tendency of wood, strands and semi-lignified stems (T.S. L) in relation to the soft part composed of green shoots (P.V.), leaves (F.L.) and twigs (B.L.).Therefore, this station is of poor quality for the biomassbecause it is almost lignified to the detriment of the green parts. Insignificant, the biomass is almost absent. It is characterized by very low and almost zero values (Fig. 8).

***Station 2*:** The values of this station are divided into three groups (Fig. 8). The first and most important group includes the values of the green parts of the plant (F.L, P.V.and B. L) with water and nitrogen contents that are highly valued by animals. In second place come the values reflecting the semi-lignified parts of the recut shrubs (B.R.) and some values of (P.V.F.Land T.S.L), before recutting. This indicates that this perimeter is healthy and ecologically balanced. The third one represented by the values of the considerable wood part before and after recutting giving to the plant the possibility to resist to the winds and to have the possibility to support the biomass for the years that follow the recutting.

***Station 3*:** In this station, the groups are clearly clearer in all four quadrants. This fragmentation expresses clearly the variability of the measured parts that compose the shrub (Fig. 8) knowing that the subjects have kept the parts before recutting and the regeneration is clear through the important values of the green leaves. It should be noted that the genus *Atriplex* has a high nitrogen content and is a rich source of protein, but it contains high levels of salts accumulated in leaves [42]**.** From a zootechnical point of view, it is recommended to use a balanced diet associated with the genus *Opuntia*, for example, to neutralize and balance the ration to avoid toxicity problems. It should be noted that the HCDS has started in recent years to plant *Opuntia* snowshoes. The interactions of the treated parameters (cut, substrate and age) gave very important rates of fresh matter and consequently a good dry matter from which, a very important biomass. Also, the soft parts of the plant exist in the second position in the second group. These treatments are considerable and can contribute to a feed intake containing more dry matter easily digestible by sheep. The balance is observed in this station by the presence in the third group of T. S. L. and B. R. from previous years. This gives an ecological sustainability of plants that have responded positively to pruning, while the last group is mainly composedof the wood parts that increase the resistivity of the clumps to the climatic and edaphic conditions, which also increases its capacity in carrying a significant biomass estimated at more than 3/4 of the total plant.



Wood (Wood), (Wood before recutting) Wood before (Wood after recutting) (B.R.), Strand (Strands), B.L. (Twigs), TSL (Semi-lignified Stem), PV (Green shoots), and FL (Leaves)

Figure 8: Principal Component Analysis (PCA) of the Treatments of the Three Stations

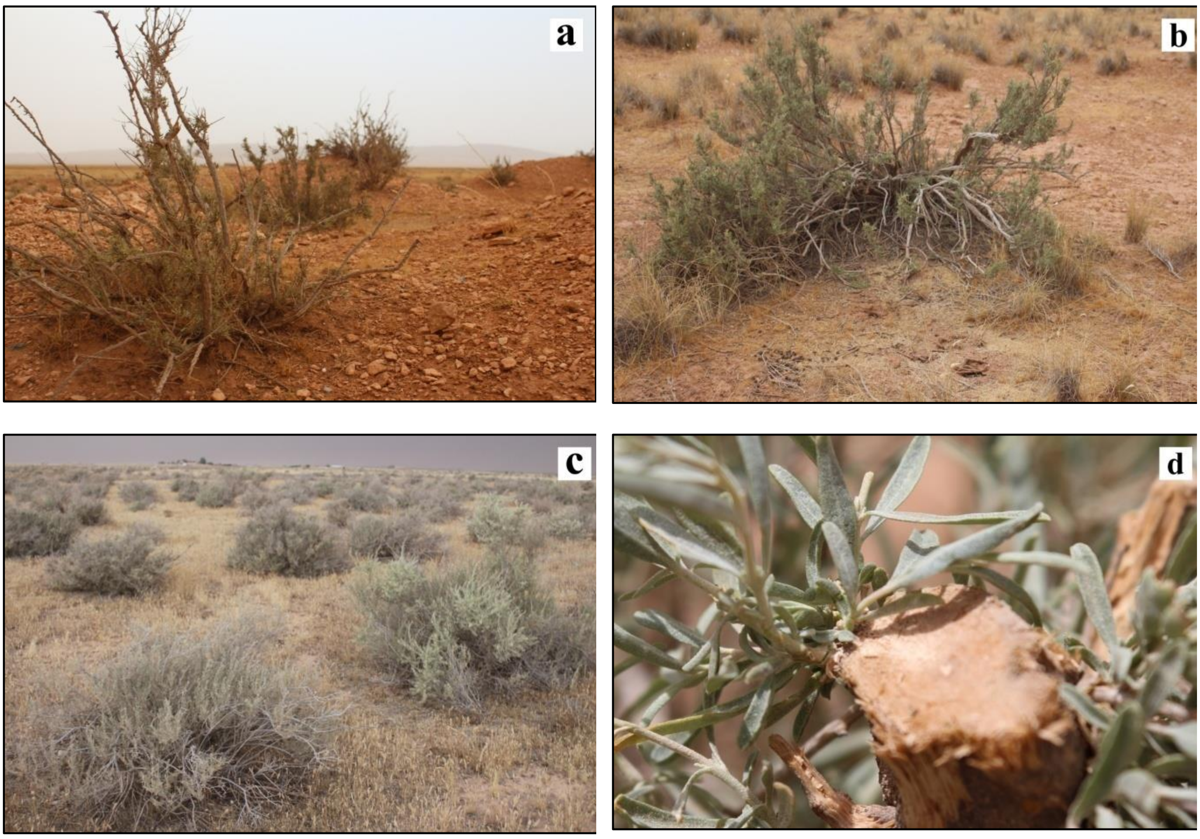


Figure 9: The effect of the coppicing *Atriplex canescens:* a: station1before coppicing; b: station2before coppicing; c: station3before coppicing; d:H10after coppicing;

Figure 9: The effect of the coppicing *Atriplex canescens:* **e**:H30 after coppicing; **f**:H50after coppicing; **g**: phytomass measurement; **h**: geolocation

CONCLUSION

The current study was confronted with the importance of the treatment of shrubs during the five years of experimentation, the spacing between the zones accentuated by the pedoclimatic constraints and the guarding of the study stations. Thesedelay some, what any restoration of steppe rangelands [33]. Despite all development programs applied to this space, it remains subject to degradation and a very low success rate for plantations [34].In Djelfa, this experiment consists in substituting biological grazing (animals) by mechanical pruning to assess its impact on the dynamics of forage plants.Although limited, it constitutes a contribution to the evaluation of the production of these rather heterogeneous slicks and should continueto ensure a better reliability of the results.

It should be noted that the H_{10} cut clumps remain interesting insofar as they have a negligible wood content and the plant is fully accessible to the animals. Nevertheless, the risks of uprooting, clearing and destruction of shrubs are very frequent. Contrary to subjects cutting back at H_{50}, they do not offer an important green phytomass but play an important role as a protective agent as a windbreak in the perimeters of the dune substratum and ensure good soil fixation. The risks encountered concern, first of all,the extremities of the branches which, by hardening, prick the lips of the oral cavities of the animals when they take food. The rate of lignification reduces the quality of the forage making it unpalatable. The almost impossible access between the corridors of the planted lines causes the cut of the wool fibers as a result of congestion, which reduces its quality for the sale of the fleece for the textile industry.

Through the observation made in this study, it appears that to achieve the double objective, pruning at H_{30}which provided a good development in height, girth and phytomass deserves a decision of applications following the different results achieved.

After 25 years of planting and pastoral development work, the data collected during the field surveys give us a summary evaluation of the results that have proved important. To be more reliable, the state should take charge of the project, since the rehabilitation of the rangelands requires adequate technical equipment and considerable resources.

The main problems encountered by the plantations are related to the high costs of their implementation and protection against overexploitation. In order not to have a fallout on the life of the pastoralists due to the ecological, social and financial crisis, it is desirable not to leave them to themselves. Their involvement, accompaniment and integration in the projects are necessary with a complex social and formative action [18] in the form of help and technical and material support for the benefit of the herders' families. It is necessary to avoid excluding them from the natural spaces of the open and preferred steppe environments, since the herder always has an essential place in any development program.

In addition to its fodder quality and its highly developed root system, the use of *A. canescens* plantations by the H.C.D.S. constitutes a promising approach in the fight against desertification thanks to its dune fixation faculty. It constitutes a biological material of choice for the enrichment of the flora and the protection of the soil in arid zones [43] in[44]

It is worth mentioning that the techniques of mechanical pruning are recommended in case of difficulties due to the inaccessibility and the shading of the old plantations where the rate of wood remains an element of a refusal by the animals [21].Comparing our results with those found by Pagliaricciet *al.* (1984) Olivares, Johnston and Fernandezcited by[18], it turns out that in *A. nummularia*, the management of these forage shrubs involves suspension of grazing after use and pruning at 25-50 cm from the ground when the plants tend to age and the vegetation moves upwards. Our results concerning the cutting levels H_{10} cm and H_{30} cm are close to those recommended by these same authors. Therefore,we conclude that the technique of recutting at these levels is of interest to sheep and makes it more profitable to graze in moderate clumps of acceptable heights and affordable diameters, interconnected in ventilated, unobtrusive corridors easily accessible to small ruminants.

The results obtained in the three stations belonging to the communes of Zaafrane, Aïn-Maabed and El Guedid (Djelfa) on the level of profitability of feed especially in DM and biomass production coincide with the data of the H. C. D. S. especially those of the fodder balance and reported by the study carried out by[35]. He was able to highlight some indicators of the success of the management actions. In fact, the introduction of feeder species and the increase in the area of feeder shrubs have given satisfactory results according to the HCDS data. Rangelands production has increased from 25 FU/ha to an average of 450 FU/ha [17].

It seems that it would make sense to establish predictive models capable of quantifying future production as a decision support tool for the exploitation and rational management of steppe rangelands [36]. The choice of species, the type of management and the monitoring of plantations by mechanical treatment of shrubs (cuts every four years) with periodic releases of animals seem to be an ideal solution.

Today, it would seem that the actions of the H.C.D.S. responsible for the steppedevelopment programs by the intensifying of the feed offer by the setting in defenses and the pastoral plantations, found more adhesion near the pastoral population [37].

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