Chapter 1

Contribution to the Assessment of Green Biomass of *Atriplex halimus* Plantation in Arid Western Algeria (Region of Naama)

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Additional information is available at the end of the chapter

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1. Introduction

In Algeria, the arid zones occupy a large surface area, more than 8 million hectares are used as rangelands. The ecological characteristics (soils holomorphic and superficial, very low rainfall) constitute constraints in the development of these spaces through the production of green biomass to be used as food to herds. The genus *Atriplex*, with *A. halimus*, *A. canescens* and *A. nummularia*, seems to possess the characteristics of an effective weapon against desertification, while maintaining a minimum of feed for livestock and allowing for high income to traditional feed systems [1]. The Atriplex are of great interest due to their hardiness, their good feed value, their high drought resistance and excellent productivity of wood. They can form the slicks to ensure good ground cover and can also be used as food by sheep and used as firewood and cooking in marginal areas. Also, its palatability is very satisfactory; the species *Atriplex halimus* constitutes a fodder very appreciated by all camelids, sheep and goats, particularly in times of drought [2]. It has been used in several programs of planning and restoration of degraded rangeland; or the level of excessive salinity and aridity edaphic are the main factors limiting the growth of plants and or there is also a need to provide fodder to the animal during the period of drought [3, 4]. The average annual production per hectare of the genus *Atriplex* remains relatively high compared to the other species introduced in the programs of development of dryland areas. This production is significant since it fluctuated between 11.5 and 14.9 tons of green matter per hectare, and in dry matter of 3.9 to 5.2 [5, 1, 6]. In Algeria, the use of the genus *Atriplex*, through the species *nummularia* and *halimus*, remain confined during thirty years in the development of rangeland. The main reasons which justify this situation find their sources in the needs food of herds in the arid areas where the grass is scarce. This gender is also

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exploited for its wood in the remote rural areas devoid of energy. All the data relating to the production of raw material palatable green and wood by the kind Atriplex justify a contribution to assess its capacity for resistance to the assaults. According to [7], rural populations are forced to exploit any available vegetation to respond to their needs in power of their herd and wood for cooking. The pastoral charge reaches more than five sheep per hectare while the opportunities are that of 0.5, which is reflected by a deterioration of plant formations or perennial herbaceous.

The average needs of rural populations for their domestic wood uses (cooking and heating) are estimated by [8] to 3 cubic meters per week. According to [9], the *Atriplex* can in certain conditions reach in biomass green supply in the order of 5 to 15 tons in Algeria and especially from 2 to 11 tons of green wood per hectare. Those figures vary considerably from one station to another, depending on the quantity of water that is actually put at the disposal of the plant and which remains a limiting factor to take into consideration because its impact is significant on the performance. In the region of Ksar Chellala (Algeria), the annual precipitation varies between 250 and 300 mm, [10] have measured the production of 2 to 5 tons of dry matter per hectare per year in the stands of *Atriplex halimus*. The plantations of *Atriplex* could therefore satisfy very quickly the real needs of local populations and would develop on all available lands. They would also probably be one of the most effective means of combating desertification and degradation as well as a considerable production of wood. The present work is a contribution to the evaluation of the production of green biomass of a plantation of *Atriplex halimus* in the region of Naama (Algeria) with the aim of controlling the temporal dimension of the production of biomass in addition to the identification of a few settings for management of Atriplexaies as the rotation duration, the period of rangeland species and productivity annual average.

2. Material and methods

2.1. Ecological characterization of the study area

The region of study is located by 33°16' N and 0° 19' W in the southern part of the west of Algeria at an altitude of 1,066 m (Figure 1). It is part of a whole geographical location called "high plains steppe" and used mainly as rangeland. The unfavourable ecological conditions (low precipitation, high thermal amplitude and sandy soils) are at the origin of the embrittlement of more and more accentuated and the reduction of pastoral ecosystems. This area belongs to the bioclimatic floor arid Mediterranean upper to cold variant with a rainfall regime of the SAWS (spring, autumn, winter, summer) seasonal type. Annually, the region of Naama receives approximately 230 mm of rain. For the follow-up period of the planting of *Atriplex halimus*, the average annual rainfall has been 219, 232 and 241 mm, respectively, for 2006–2007, 2007–2008 and 2008–2009. The average minimum temperature is of –1.1°C in the month of December and the average maximum temperature reached 35.9°C in the month of July. It is a steppe space that serves as a route to sheep

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breeding. The dominant soils (soils red and brown limestone) are of the steppe type, characterized by a superficial horizon of low depth (less than 25 cm), texture of sandy-loam to sandy-clay loam and slightly saline, a rate of organic matter of 0.7 % and a very low water-holding capacity, and a slightly basic pH.

For the assessment of the evolution of the production of green biomass of a plantation of *Atriplex halimus*, the choice has focused on a plantation for the value of a steppe soil bare on 500 ha (2,500 by 2,000 m) with plants of *Atriplex halimus* at a density of 2,500 plants per hectare. The seedlings are grown in the nursery of Bel Handjir in the region of Ain Sefra (same area as the perimeter of plantation), during 8 months in polyethylene bags of 9 cm in diameter and 20 cm depth. Their average height at planting was 37 cm with a main stem of 0.6 cm in diameter. The preparation has consisted of the opening of holes of planting of 40 cm depth and 30 cm side. The planting of *Atriplex halimus* was held the month of October 2006. On this plantation, three plots of 1,000 m^2 (50 by 20 m) each, far from one another 500 m according to an east–west diagonal to avoid the border effect, have been protected by a fence and monitored during 3 years. At the level of each parcel, annually have been materialized three plots of 100 m^2 (10 by 10 m) arranged in a diagonal north–south and at intervals of 10 m for a total of nine plots. An assessment of the green biomass was carried out each year in mid-October during 3 years (2007 to 2009). The average annual increase in leaf and stem has been calculated according to the following formula:

$$TAAM = \left(\sqrt[n]{\frac{final\ value}{initial\ value}} - 1 \right) \times 100$$

TAAM: (Average Annual Rate of Increase)

A **year after planting,** either in October 2007, slices at the ras of the soil have been carried out on the plots of 100 m^2 for assessing the green biomass occurred by stem used as wood for the home energy and in sheets used as livestock feed. The data have been processed by an analysis of single- factor variance organized in block, followed by a comparison of averages two to two according to the test of Newman and Keuls (software Statbox 6-4).

3. Result

The results obtained, converted to kilogram per hectare after evaluation of the green biomass of leaves and wood, are summarized in Tables 1, 2 and 3. The biomasses measured tend to increase very significantly ($p < 0.01$) in the time (Table I). The production of green biomass of leaves by planting of the *Atriplex halimus* is estimated at 5,377 kg in 3 years, resulting in an average annual increase of 1,792 kg per hectare of green leaves, or an average annual rate of 55.0%. The production of green biomass of stems is estimated at 3,358 kg, or an average annual increase of 1,119 kg per hectare, representing an annual average rate of 62.3%. The results of the biomass leaves and stems obtained are used to assess the annual average production of a plantation of *Atriplex halimus* in arid zone. This plant shows a very interesting and significant average increase compared to that of other species used for the development of rangeland.



Figure 1. Map of study site (Naama) in Algeria.

Periods of observations	October 2006	October 2007	October 2008	October 2009
Green biomass of leaves	1,125	3,913 ± 9,313	543 ± 7,348	6,502 ± 7,348
Green biomass of stems	559	1,124 ± 15,378	3,192 ± 5,385	3,917 ± 9,669
Total Biomass	1,684	5,037 ± 15,190	8,628 ± 10,5	10,419 ± 15,223

GBL: Green biomass of leaves. **GBW**: Green biomass of wood.

Table 1. Assessment of the green biomass (leaves and stems) over a period of 3 years

Type de Biomasse	October 2007	October 2008	October 2009	analysis of variance (Effect period)
GBL	3,913 [c] ± 7,511	5,436 [b] ± 4,491	6,502 [a] ± 5,909	** ($p < 0.01$)
GBW	1,124 [c] ± 9,531	3,192 [b] ± 7,439	3,917 [a] ± 5,346	** ($p < 0.01$)
GBT	5,037 [c] ± 11,529	8,628 [b] ± 8,347	10,419 [a] ± 8,981	** ($p < 0.01$)

dof: Degree of Freedom**; GBL:** Green biomass of leaves**. GBW:** Green biomass of wood.

GBT: Total Biomass**. ** Probability significant at *P* <0,01**.

Table 2. Assessment of aboveground biomass produced (stems and wood in kg/ha)

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Periods of observations	October 2007			October 2008			October 2009		
	GBL	**GBW**	**GBT**	**GBL**	**GBW**	**GBT**	**GBL**	**GBW**	**GBT**
1	3,901	1,120	5,021	5,448	3,199	8,647	6,512	3,927	10,439
2	3,918	1,129	5,047	5,440	3,200	8,640	6,510	3,921	10,431
3	3,921	1,112	5,033	5,429	3,193	8,622	6,501	3,901	10,402
4	3,924	1,093	5,017	5,439	3,188	8,627	6,490	3,904	10,394
5	3,912	1,148	5,060	5,438	3,187	8,625	6,497	3,911	10,408
6	3,902	1,122	5,024	5,431	3,184	8,615	6,500	3,916	10,416
7	3,906	1,127	5,033	5,426	3,195	8,621	6,495	3,925	10,420
8	3,925	1,130	5,055	5,443	3,192	8,635	6,508	3,922	10,430
9	3,908	1,135	5,043	5,430	3,190	8,620	6,505	3,926	10,431
Average	**3,913**	**1,124**	**5,037**	**5,436**	**3,192**	**8,628**	**6,502**	**3,917**	**10,419**
Average Annual Growth (AAG)	**2,788**	**565**	**3,353**	**1,523**	**2,068**	**3,591**	**1,066**	**725**	**1,791**

Table 3. Assessment of the green biomass (leaves and stems) over a period of 3 years 2007 to 2009

4. Discussion

The results obtained in green biomass both of leaves and of stems allow you to emphasize the interesting capacity for production of the species *Atriplex halimus*. The average annual increase of the green biomass total is estimated at 2,911 kg per hectare, a yearly average rate of increase of 57.7%, a value very interesting in an arid zone. According to [11] and [5], concerning production of the genus *Atriplex* ensured, according to the instalment rainfall, a dry biomass oscillating between 1,000 and 3,000 kg/ha under conditions of rainfall ranging between 100 and 400 mm. The water-use efficiency by the plant fluctuated between 10 and 20 kg of dry matter/ha per mm of rain. In Morocco, 3 years after implantation, a plantation of *Atriplex nummularia* having a density of 1,000 plants /ha has produced 1,273 kg /ha, of which nearly 31% of wood, equivalent to 625 FU and 200 kg of raw protein/ha [12]. All the authors agree to emphasize that the maximum yield of the genus *Atriplex* is around 6,500 kg of dry matter per ha under precipitation greater than 400 mm. This species is also important with regard to the production of woody biomass in extreme environmental conditions such as those of southern Morocco [13]. Compared to the other yields observed across the world (Morocco, Australia, Tunisia), the results obtained in area of Naama (Algeria) remain very appreciable and constitute a repository that can be used to justify such plantations in the high plains steppe Algerian. The experimentation carried out has allowed to determine that the duration of protection of the plantation that allows you to have the best returns is of at least 3 years for

both the green biomass of leaves and stems. It follows a triennial rotation in case of use by the herds. Therefore, the duration of exploitation by cut or by release of herds in a plantation of *Atriplex halimus* in similar conditions cannot be less than 3 years.

5. Conclusion

The results obtained indicate that the capacity for growth and production of biomass and wood is very large compared to other shrubs. The average annual increase in total biomass is around 58%; In addition to its protective role of the soil and production of fodder units, *Atriplex halimus* allows to produce a woody biomass appreciable in the first year of planting. Therefore, the production of interesting green biomass and wood of *Atriplex halimus* allows to answer three basic needs in these arid spaces. The improvement, with the contribution of green biomass and a deep rooting, of physical and biological characteristics of land threatened by desertification and salinization, the availability of a green biomass serving palatable feed for the herd and the use of wood as domestic energy renewable. Knowing that all the plantations of *Atriplex* in Algeria are subject to exploitation by the herds in search of fodder units rare in the arid areas for the first year, it appears urgent to proceed to the prohibition of grazing for 3 years to ensure better yields. This prohibition of grazing would also respond to the needs in wood for cooking and heating of the nomadic populations and riparian plantings, using the stems of *Atriplex halimus* which are not consumed by the sheeps. In the light of the very encouraging results, the use of *Atriplex halimus* could be generalized under the climatic and edaphic conditions similar to those of the experiment since it allows a supplementary feeding forage and a source of renewable energy for heating and cooking in semi-desert area.

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References

[1] Le Houérou HN. Utilization of fodder trees and shrubs in the arid and semi arid zones of west Asia and North Africa. Arid Soil Res Rehab 2000;14:101–35.

[2] Kinet JM, Benrebiha F, Bouzid S, Laihacar S, Dutuit P. Biodiversity study on Atriplex halimus for in vitro and in vivo detection of plants resistant to harsh environmental conditions and for potential micropropagation. Cahier Agricult 1998;7:505–9.

[3] Le Houérou HN. The role of saltbushes (Atriplex spp.) in arid grazing land rehabilitation in the Mediterranean basin: a review. Agroforestry Syst 1992;18:107–48.

[4] Bajji M, Kinet JM, Lutts S. Osmotic and ionic effects of NaCl on germination, early seeding growth, and ion content of *Atriplex halimus* (Chenopodiaceae). Can J Bot 2002;80:297–304.

[5] Correal A, Otal J, Belmonte C, Sotomayor JA. Evolution of sheep production under continuous rotation grazing of a salt bush plantation of Atriplex sp. in south-east Spain. In: 4th Int. Rangeland Congress. Montpellier, France. 1990;1:422–25.

[6] Cherouk A. Contribution to the definition of a methodology to estimate the biomass *of Atriplex nummularia* in eastern Morocco. In: Gintzburge G, Bounejmate M, Nefzaoui A. (Eds.) Fodder shrub development in arid and semi-arid zones. Proceedings of the workshop on native and exotic fodder shrubs in arid and semi-arid zones, 27 October to 2 November 1996, Hammamet, Tunisia. Vol. II. ICARDA, Aleppo (Syria) 2000, pp. 334–339.

[7] Benabdeli K. Aspects physiognomic-structure of the woody vegetation facing the anthropologenetic pressure in western Algeria. PhD thesis of State, University of Sidi Bel Abbes, 1996.

[8] Benabdeli K. Methodology for assessing the impact of man and animal on the woody formations. PhD thesis of specialty, University of Aix-Marseille II, 1983.

[9] Ouadah Y. Contribution to the study of the main species of interest feed of arid and semi-arid regions of Algeria. Application to a few species. Memory of end of study, INA, Algiers, 1982.

[10] Rodin LE, Botschantzen V, Kalenov H, Miroshnichenco YM, Pelt N, Vinogradov B. Geo-botanical studies the pastures of the western sector of the department of the Medea (Algeria). Naouka Ed., Leningrad, 1970.

[11] Forti M. Introduction of fodder shrubs and their evaluation for use in the semiarid areas of the northwest Neveg. Institute for Arid Zones Research, Bear- Sheva, Israel. Minco, 1971.

[12] El Mourid M, Malki M, Sbeita A, Chiriyaa A, Nefzaoui A, Shideed K, Haj Hass an Aawawedha F, Sweidan SY. Crop livestock integration: alternatives to stop desertification in arid regions: WANA expert meeting: scientific research and its role in combating desertification and stabilizing sand dunes. Taghit, Algeria November, 2001, 4–6.

[13] Benchaabane A. *Atriplex halimus* L.: source of firewood and fodder in arid environments (case of the region of Marrakech, Morocco). In: Gintzburge G, Bounejmate M, Nefzaoui A. (Eds.). Fodder shrub development in arid and semi-arid zones. Proceedings of the workshop on native and exotic fodder shrubs in arid and semi-arid zones, 27 October to 2 November 1996, Hammamet, Tunisia. Vol. II. ICARDA, Aleppo (Syria) 2000, pp.610–616.