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# Effect of *Atriplex Halimus* on Indicators of soil erodibility (Case Study: Incheborun, Golestan Province).

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## ABSTRACT

Vegetation deterioration is a main cause of erosion and land degradation. Therefore, land cover reclamation in the effected areas will affect erosion trend. In reclamation projects, the investigation of relationship between the planted species and soils is highly recommended. *Atriplex* species can sequester carbon into soil, and have an ability to conserve soil and prevent soil erosion, as well. Therefore, they are considered suitable species, particularly their adaptations to arid conditions of Iran. For that reason, especial attention has been paid to planting of these species in the drylands of northern part of Golestan province. This study is an attempt to evaluate the effects of planting this species on the status quo of wind and water erosion indices in the area. Therefore, soil samples were taken via the random method. After the measuring of the physiochemical properties of the soil samples in the laboratory, the data were subjected to ANOVA using statistical software SPSS 21. The sufficiency of mean differences were evaluated by T-test at p value $\leq 0.05$. Results of this study showed that *Atriplex* is capable of significantly enhancing soil aggregate stability and thereby lessening erosion. Thus, this could play a major role in harnessing soil erosion and improving soil conservation measures. Therefore, this plant could effectively reduce soil erosion in the area.

**Keywords**: Atriplex, Indicator, Soil erodibility, Ratio of clay, Ratio of modified clay, Mean weighted diameter, Vegetation, Drylands, T-test, Golestan.

## INTRODUCTION

In arid and semi-arid regions, soil erosion and desertification are among processes, which endanger soil and water resources directly and indirectly. Although, these processes are natural events, and avoiding prevention from it is impossible, but this is necessary to reduce their velocity and intensity. In order to improve vegetation cover and to stabilize the sand dunes of marginal areas of desert lands, it requires the cultivating of some plants that can enhance the bio-physiochemical properties of surface soil, in addition to adapting with harsh environmental conditions of drylands. For this reason, Amaranthaceae family has great importance; especially one of the most important species is *Atriplex halimus*, which is productive in

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the transmutation of agents or components of natural environment. The growing of this plant might have positive or negative effect on soil properties, local plants, and creatures in the natural environment. Plant biomass leads to the increase of soil productivity, soil fertility, and water holding capacity of soil. As dynamic characteristics in soil nature, erodability depends heavily on the soil aggregate stability and percentage of initial coarse particles (resistance to erosion). Soil erodability in its broadest definition, is the inherent tendency of soil or aggregates towards disintegration under various erosive agents such as raindrop kinetic energy, iteration of wet and dry spells and soil depression (10). Even though a rough estimate of the soil characteristics could not imply soil erosion status thoroughly, some characteristics especially the development and stability of soil aggregation may indirectly affect soil erodability (3). Once erosion factors overcome inner soil cohesion strength, soil aggregate would collapse into fine particles that in return decrease infiltration rate. The latter could result in high runoff and soil degradation. The process of soil aggregate disintegration is regarded as an essential prerequisite of soil degradation and hence soil erosion (4). In order to rehabilitate and outspread vegetation in arid and semi-arid areas, understanding soil aggregate stability against different erosive agents and reducing the level of carbon dioxide emission are advantageous. Presence of vegetation cover on soil surface and increased biological activities at this level may enforce soil aggregate stability such that soil structural strength and percentage of stable soil aggregates at the soil surface will overtake those amounts of lower depths (2). There is close relation between aggregate stability and soil erosion that is confirmed by different erodability indices in relation to aggregate stability (7). Optimal management of soils by increasing soil organic matter causes increased aggregate stability, maintenance of soil fertility and improvement of physical and chemical properties of soils. Therefore, stability and appropriateness of managements can be surveyed by measurement of aggregate stability in similar soils under different managements. *Atriplex halimus* can tolerate harsh environment conditions; furthermore, considering versatile utility of *Atriplex* such as suitable yield forage, proportional nutritious value, appropriate growth in saline and alkaline lands, being of vegetation cover, it requires to conduct scientific researches about this vital plant to get comprehensive and scientific information about its development or limit of cultivating of this plant. The purpose of this study is to evaluate the effects of *Atriplex halimus* on some soil properties, carbon sequestration, the rehabilitation and stabilization of sand dunes.

## MATERIALS AND METHODS

The study area is in Incheborun, about 55 km far away from Gorgan (the capital of Golestan province) and 30 km of north of Aqqala city, Iran. The study area is about 4 meters above sea level. The climate of this region, based on the meteorological records of Incheborun station, is xerothermic, having moderate and semi-arid climate. The average rainfall is about 304mm per a year, and it falls mainly from November and May. The soil has moderate texture with high alkaline and saline condition. The landforms of the study area mainly consist of sandy hills and plain lands. The project of *Atriplex* plantation has begun since 1984; approximately 3500 hectares of rangelands are allocated to *Atriplex* in hills (loess lands).

At fieldwork, soil sampling has been done using a random method. In this study, we used 3 transects with 100 meters in length. The transect interval was about 50 meters for each sampling. About 30 soil samples has been collected from the study area under vegetation cover. Soil sampling has been taken from the horizon of soil (0-30cm). In addition, 30 samples are taken from the same depth from the control area. Soil samples has brought to laboratory for the measuring of the considered parameters. For statistical analyses via analysis of variance (ANOVA) test ,and Duncan test and comparing two mean (T-test), soil properties in *Atriplex* area and the control has been compared. Index CR (ratio of clay) (1) is calculated the equation (2-1), as follows:

$$CR = \frac{\text{sand \%+ silt \%}}{\%clay} \qquad (2\text{-}1)$$

odibility parameters that are examined include:

Index CR (ratio of clay)
Index MCR (ratio of modified clay)
Index MWD (mean weighted diameter)

Index MCR (ratio of modified clay) (6) is calculated the following equation (2-2)

$$MCR = \frac{\text{sand \%+ silt \%}}{\%clay + \text{Organic matter}} \qquad (2\text{-}2)$$

Index MWD (mean weighted diameter) (5), the equation (2-3), was calculated:

$$MWD = \sum_{i=1}^{n} x_i \times w_i \qquad (2\text{-}3)$$

where $w_i$ is the ratio of aggregates weight in each sieve to total weight, and $x_i$ aggregate mean diameter of each sieve (the mean diameter of the upper and lower sieves).

## RESULTS AND DISCUSSION

Given what is concluded, the MWD has undergone a significant change from areas planted with *Atriplex* compared with those lacking it. In fact, *Atriplex* has improved soil aggregate stability which as a result could control erosion. On the other hand, the MCR level in the rehabilitated areas with *Atriplex* compared with control plot, has changed meaningfully. As a matter of fact, the MCR level decreases under *Atriplex* planted areas. There is significant difference between rehabilitated lands by *Atriplex* and control area considering the rate of CR. The results of the analysis of variance showed that soil erodability indices are significant at level 5% at two planted area with *Atriplex* and control area.

**Table 1 .**Comparison of mean values of soil erodibility indices in control and Atriplex areas (at the 5% significance level)

| Treatments | MCR | CR | MWD |
|---|---|---|---|
| Control area | 12.94[a] | 10.6[a] | 0.54[a] |
| The cultivated ( Atriplex area) | 9.86[b] | 12.54[b] | 0.64[b] |

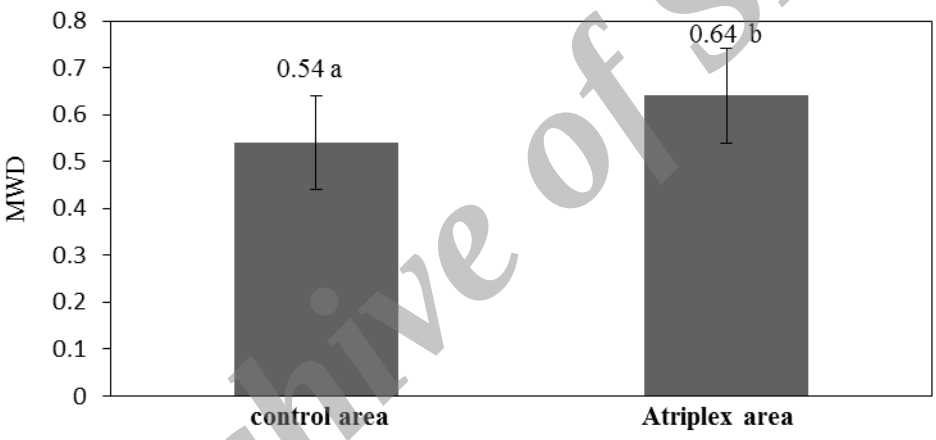


**Fig. 1.** Comparison of MWD in the control and *Atriplex* areas

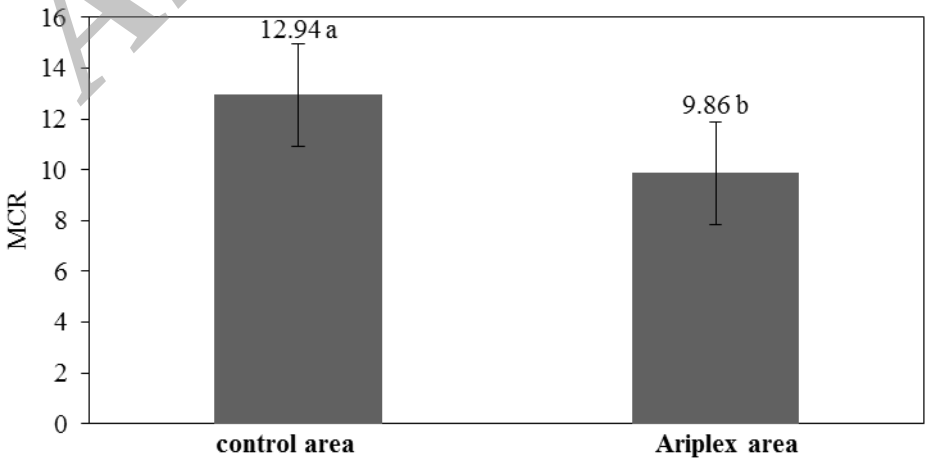

**Fig. 2.** Comparison of MCR in the control and *Atriplex* areas

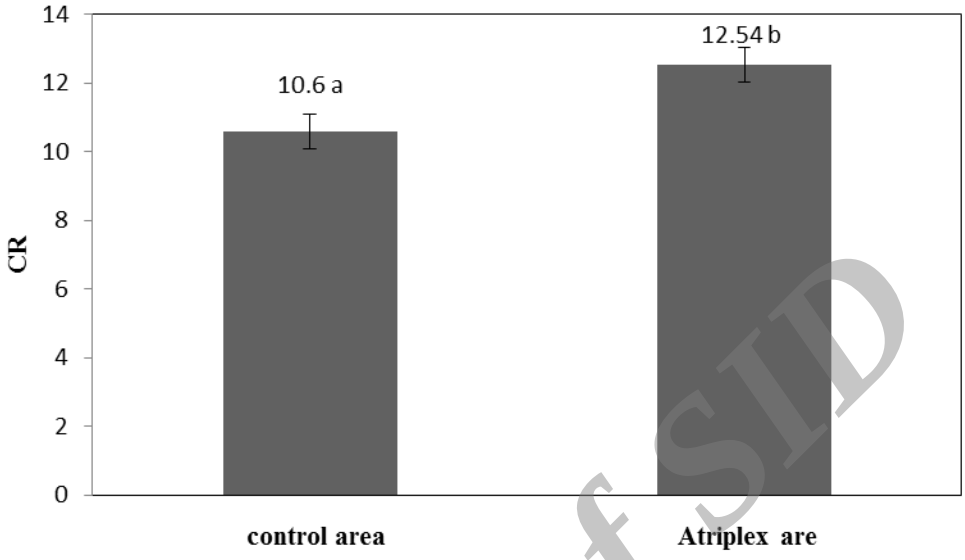


**Fig. 3.** Comparison of CR in the control and *Atriplex* areas

## CONCLUSION

Erosion is one of the key adverse processes in arid and semi arid ecosystems of Iran. In order to better understand this process, effecting factors on soils should be examined in these regions.One of the effecting factors on soil erosion is aggregate stability and recognizing its changing factors can help for resolution of region problems. Soil erodability is defined as quantitative expression of the inherent susceptibility of soil to the detachment of the particles from bed and its transportation by erosive factors such as rain and runoff. Erodability is the resulting impact of physiochemical characteristics of soil and interaction between them. Among these factors, aggregate stability and soil physical or mechanical resistance are most effective factors on soil erosion and sediment transport (8). Obtained results of soil stability measurement by wet sieving showed that mean weight diameter (MWD) is high in planted lands with *Atriplex*. Aggregate stability in studied region is not just affected by organic material. Lower aggregate stability in areas planted with *Atriplex* is due to other factors such as higher rate of EC. The development of this plant according to salinity in the soil surface layer can cause negative impact on soil aggregate stability. CR has made a significant difference between studied and control area. The amount of clay and silt are effective factors on aggregate stability and it can be noted that the amount of clay and silt has reduced in studied area. Obtained results from comparing MCR index is indicating significant difference in planted area with *Atriplex* and control area that can be attributed to significant difference of silt percent. By appropriate ecological management, we can take steps in the increasing of biomass. Alongside other ecological and economical study, *Atriplex* planting is considered as a protective species for stabilizing mobile sand dunes, which is threatening area's life. In addition to importance and high adaption of *Atriplex* to drylands in Iran, and the importance of this plant in providing forage for livestock, it has a verity

usefulness. The planting of this species improves physiochemical properties of soil, so planting this species is suggested for confronting the wind erosion and water erosion, reducing greenhouse effects and global warming. Considering the ever- importance of the importance of soil erosion control in the desertified areas of Iran, the necessity of conducting more researches to estimate the wind erosion and water erosion and applying results in combating desertification is suggested. Considering that the plant planting soil erodibility index was reduced, so the erosion control plan to deal with the water and wind erosion, is suggested.

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