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# Evaluation of the Consortium with *Salicornia Neei* for Use in the Semi-Arid of Pernambuco. I - *Nopalea cochenillifera* (Small Palm)

**G. C. de M. Barreto[1], J. G. Fernandes[2] and A. S. Messias[3]***

[1]*Graduate student in the Master in Development of Environmental Processes, Catholic University of Pernambuco, Recife, Pernambuco, Brazil.*

[2]*Agronomic Institute of Pernambuco - IPA, Recife, Pernambuco, Brazil.*

[3]*Teacher at Catholic University of Pernambuco, Recife, Pernambuco, Brazil.*

***Corresponding Author:** A. S. Messias, Teacher at Catholic University of Pernambuco, Recife, Pernambuco, Brazil.*

## ABSTRACT

*The semi-arid region of Pernambuco has climatic, pedological and hydrological characteristics that give the region restrictions on the regular use of aquifers, requiring a diversity of vegetation resistant to drought and soil salinization.As aresult of this particularity, it is necessary to cultivate halophyte plants that support living in soils with high salinity content, as they absorb salt, collaborating for the recovery of soils and serving as human and animal food.The search for low-cost alternatives that suit the peculiarity of the environment is continuous and requires efficient alternatives that can bring benefits to the local farmer.The objective of this work was to evaluate the effect of the consortium between Salicornia neei and Nopalea cochenillifera(small palm). The experiment was carried out in a greenhouse located at the headquarters of the Agronomic Institute of Pernambuco (IPA), in Recife, Pernambuco, with three soil textures.The experimental design used was a randomized block, with Salicornia neei and small palm individualized and intercropped and irrigated with water (control) and with desalinator reject, with three replications.After 180 days, it was observed that Salicornia neei and small palm(Nopalea cochenillifera) intercropped presented a better production of green and dry matter when irrigated with desalination waste and cultivated in the soil with sandy texture.*

**Keywords:** *Halophyte; Saline water; Plant growth; Small palm.*

## INTRODUCTION

The Brazilian Northeast has a peculiar characteristic: the presence of a semi-arid climate, which has a high temperature, ranging from 23 to 27ºC; annual rainfall, which is around 800mm per year, with irregular distribution; low air humidity; high evaporation, causing water deficit in the soil at various times of the year. These conditions hinder the production of forage during periods of drought, making it necessary to search for alternatives for the implantation of crops, which are tolerant and adaptable to high air temperatures and low rainfall regimes, thus mitigating such adversities [1, 2].

According to[3],the production of food through saline agriculture is practiced in coastal areas and arid regions with saline soils, through the conscious use of natural resources and for the economic development of the region. For this, it requires the use of plants that have morphological and / or physiological mechanisms tolerant to salinity and that have a high nutritional content.

The presence of salinity in the semi-arid region of Pernambuco is one of the major problems for local farmers, as they are obliged to use water for irrigation with high concentrations of salt in food production. It is necessary to cultivate halophytes for human and animal food[4].

*Salicornia neei*, known as green asparagus, and the small palm (*Nopalea cochenillifera*), stand out for being resistant to salinity. *Salicornia neei* is an example of a halophyte used for phytoremediation in degraded soils and has a large biomass production. The cochineal cactus is a cactaceous well adapted to the adverse conditions of the semiarid region, representing a large part of the foods that make up the diet of ruminants in the dry season, in most of the semiarid region of the Brazilian Northeast,

precisely in Alagoas' hinterland and in Pernambuco's and Paraíba's dry lands. Due to their morphophysiological and anatomical characteristics, allowing adaptation to different water availability scenarios, these plants are successfully grown in these regions [4, 5, 6, 7].

The cultivation of small palm is an option favorable to the edaphoclimatic conditions of the region, being a food supply for animals in the dry season, due to the lower water requirement of the crop and the high production of phytomass, high energy value, high yield of fresh biomass, good acceptability and digestibility, large water reserve in its structures and easy to propagate [8, 9, 10, 11].

Considering the need to maximize productivity levels, the proper use of crop management is relevant for the farmer, helping to gradually increase the production of the implanted crops. In this case, the adoption of a consortium system and the use of irrigation, favor improvements in the development and productivity of crops - which means that two or more cultures of different species simultaneously in the same area intercrop, significantly reducing the difficulties arising from salinized soil and the precarious water in the semiarid region[1].

The use of *Nopalea cochenillifera* and *Salicornia neei* in a consortium way in the semiarid region in Pernambuco is of great relevance for local farmers, because, besides being plants with a high potential for phytoextraction, they have satisfactory bromatological characteristics, being *Salicornia neei* a very promising species for cultivation in the saline region, since it has high nutritional content for both human and animal diets [3].

The objective of this work was to evaluate the effect of the consortium between *Salicornia neei* and *Nopalea cochenillifera*, on growth and productivity in greenhouse cultivation, submitted to irrigation with desalinator reject.

## MATERIALS AND METHODS

### Obtaining Seedlings

The production of seedlings by vegetative propagation of *Salicornia neei Lag.* was performed directly on the vessels to be used in the experiments. Stem fragments (cuttings, 10 cm long) were removed from the matrix plants, with the lower part in a bevel. These cuttings were placed in pots with soil with clayey, medium and sandy textures. For 30 days the plants were irrigated with drinking water and, every three days, they were sprayed with desalinator reject to acclimatize them, until rooting.

The small palm (*Nopalea cochenillifera*) was collected at the Arcoverde Experimental Station of the Agronomic Institute of Pernambuco (IPA).When planting, the position of the article, which is a cladode, also called a racket and "leaf" by the producer, was vertical inside the pit, with the cut part of the joint facing the ground, planted in the position of the smallest width of the article.

### Conducting the Experiment

The experiment was carried out under greenhouse conditions, located at the headquarters of the Agronomic Institute of Pernambuco (IPA), in Recife, Pernambuco.

Black polyethylene pots were used, with eight kilos of saline soil with clay, medium and sandy textures, from the São Bento do Una Experimental Station, IPA, air-dried, ground, homogenized and sieved in 2mm mesh for fertility analysis according to Table 1.

**Table1.** *Soil fertility analysis used in the experiment*

| Determination | Soil Sandy Texture | Soil Average Texture | Soil Clay Texture |
|---|---|---|---|
| pH ($H_2O$) | 6.40 | 5.50 | 7.40 |
| P, $mg/dm^3$ | 13 | 105 | 209 |
| Ca, $cmol_c/dm^3$ | 0.40 | 0.90 | 12.40 |
| Mg, $cmol_c/dm^3$ | 0.60 | 0.60 | 2.20 |
| Na, $cmol_c/dm^3$ | 0.05 | 0.11 | 4.09 |
| K, $cmol_c/dm^3$ | 0.08 | 0.05 | 0.60 |
| Al, $cmol_c/dm^3$ | 0.00 | 0.30 | 0.00 |
| H, $cmol_c/dm^3$ | 0.33 | 1.35 | 0.25 |
| S, $cmol_c/dm^3$ | 1.1 | 1.7 | 19.3 |
| CTC, $cmol_c/dm^3$ | 1.5 | 3.3 | 19.5 |
| V, % | 77 | 50 | 99 |
| m, % | 0 | 15 | 0 |

**Where:** *S = Sum of Bases; CTC = Cation Exchange Capacity; V = Percentage of Saturation by Base; m = Percentage of Saturation by Aluminium.*

**Source:** *Soil Fertility Laboratory of the Agronomic Institute of Pernambuco - IPA, Recife, Pernambuco (2019).*

The treatments consisted of the individual planting of *Salicornia neei* and small palm, as well as intercropped, in the three types of saline soil textures, with irrigation with water (control) and with the desalinator reject, observing the development plants for up to 180 days.

The experimental design used was randomized blocks, with the treatments: individualized Salicornia and small palm and intercropped Salicornia and small palm, three soil textures (clayey, sandy and medium), with two types of irrigation (with control water and desalination waste), with three replications, totaling 54 experimental units.

Throughout the experiment, humidity was maintained in the pot capacity, by weighing the pots and daily watering with drinking water and with the desalination waste from the municipality of Riacho das Almas, Pernambuco, to complement the water lost through eva potranspiration, with the following features: Electrical Conductivity = 11.54 mS/cm at 25ºC, $Ca^{2+}$ = 403 mg/L, $Mg^{2+}$ = 393.09 mg/L, $Na^{+}$ = 200 mg/L and $K^{+}$ = 40 mg/L, Sodium Adsorption Ratio (SAR) = 23.67, pH = 7.9, Classification for irrigation = C4S4 (Very high salinity water and high sodium concentration).

### Collection of the Experiment

After the experimental period, the aerial part of the small palm and the salicornia were collected, separating them at the height of the plants' neck, and washed with deionized water. To evaluate the yield of cultivated plants, the green matter weight (GMW) was analyzed on the day of harvest. That done, all the material was packed in paper bags, dried in an air circulation oven, at 60ºC, for 72 hours, to determine the dry matter yield (DMP).

Immediately afterwards, the material was milled, in a Wiley mill, provided with a 42 mm sieve for, through nitroperchloric digestion[12], the contents of the absorbed elements ($Na^{+}$, $K^{+}$, $Ca^{2+}$, $Mg^{2+}$) and total nitrogen were determined by the microkjeldhal method, as well as the bromatological analysis[12]. A soil sample, as well, was collected for complete chemical analysis [13].

### Statistical Analysis

The data obtained were submitted to individual and joint statistical analysis, relevant to the variables studied, using appropriate mathematical models, through analysis of variance (ANOVA) and the F testwith the help of the MINITAB US.2018 statistical package.

## Results and Discussion

In Fig. 1a, it is possible to observe that the treatment with intercropped *Salicornia neei* and small palm (*Nopalea cochenillifera*) showed a better production of green matter (GMW), equal to 1,216.74kg/ha, when irrigated with desalination waste and grown in soil with sandy texture, compared to clayey texture soil, water irrigation, only cochineal cactus (0.00kg/ha) and sandy texture soil, irrigation with desalinator reject, only cochineal cactus (746.60kg/ha).

Knowing that small palm (*Nopalea cochenillifera*) is a demanding crop in terms of soil characteristics, which must have good fertility, sandy to clayey texture, efficient drainage[14], it is clear that the consortium with *Salicornia neei* favored an increase of 470.14 kg/ha in GMW, indicating a probable adaptation of the consortium to the climate of the Pernambuco semiarid region.

In Fig. 1b, it is possible to observe that the treatment with intercropped Salicornia neei and small palmpresented a better production of dry matter (DMP), equal to 243.35kg/ha, when irrigated with desalinator reject and grown in sandy texture soil, compared to clayey texture soil, water irrigation, only small palm(0.00kg/ha) and sandy texture soil, irrigation with tailings, only small palm(149.32kg/ha).

Small palm is a forage considered an energy source with great potential for feeding ruminants. However, it has low levels of dry matter (DM) in relation to the recommended minimum levels indicated for these animals [15] and, in this study, the consortium with *Salicornia neei* favored an increase of 94.03 kg/ha in DMP.

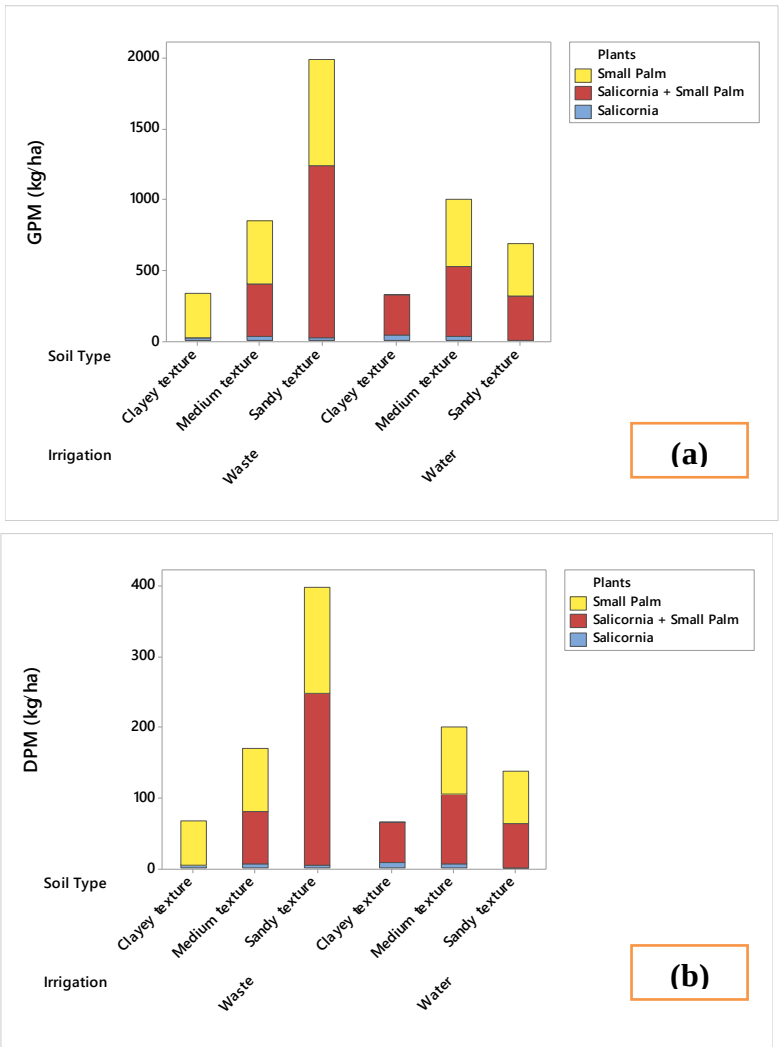
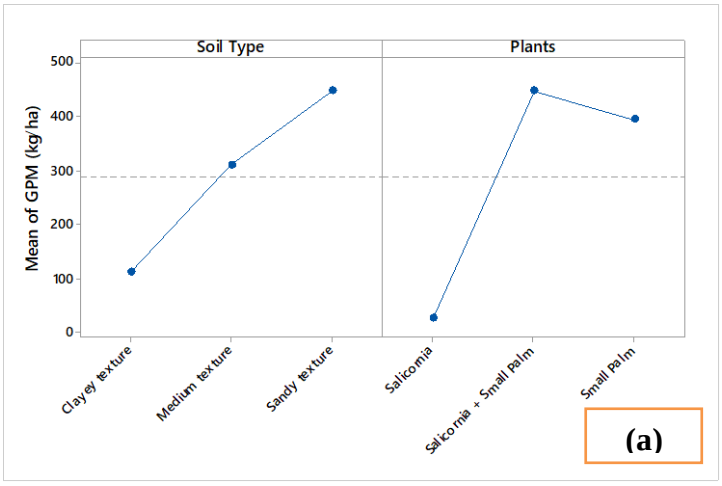



**Fig1.** *Results obtained for the production of green matter -GMP (a) and dry - DMP (b) from Salicornia neei intercropped, or not, with small palm (Nopalea cochenillifera), in three different textures of soils and irrigated with water and desalinator reject*

It can be seen, in Fig.2 (a) and (b), the upward effect on plant growth (increased production of green matter - GMP (a) and dry - DMP (b)) starting from the clayey textured soil, passing through the mixed texture and reaching the summit in the soil with sandy texture. Likewise, analyzing the Plant factor: the use of the Salicornia neei and small palm consortium revealed the significant growth in GMP and DMP.



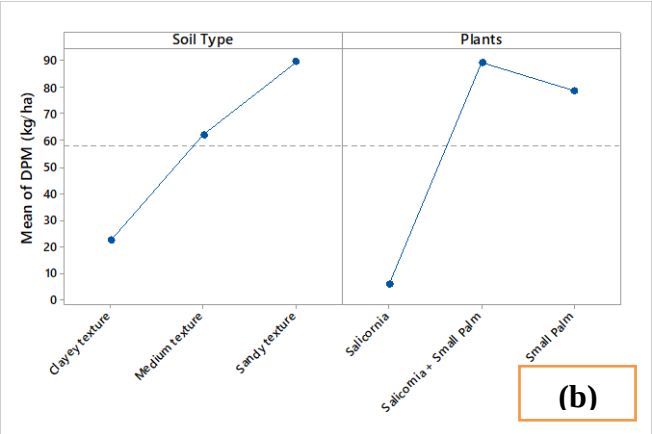



**Fig2.** *Results obtained for the upward effect of green matter production - GMP (a) and dry - DMP (b) from Salicornia neei intercropped, or not, with small palm(Nopalea cochenillifera), in three different soil textures*

In Fig. 3, it is observed, through the simultaneous optimization of the studied variables that, even though itis considered a halophyte, *Salicornia neei* responded satisfactorily to the absorption of $Na^+$ (4.27%), $K^+$ (3.37%), $Ca^{2+}$ (2.36%) and $Mg^{2+}$ (4.38%) when irrigated with water, in the sandy texture soil, increasing, therefore, the production of green matter (GMP) and consequent production of dry matter (DMP).So, the consortium of *Salicornia neei* with small palm was favored by the increase in nutrients and good productivity, serving as animal and human food.

According[4] the influence of line and row spacing on biomass yield and minerals absorbed by *Salicornia neei* irrigated with desalinator reject, in field conditions. Regarding phytoextraction by *Salicornia neei*, the most efficient spacing was: 20x20cm for sodium- $Na^+$ (15.5%); 30x30cm for potassium- $K^+$ (3.00%) and 40x40cm for calcium- $Ca^{2+}$ (4.18%) and magnesium- $Mg^{2+}$ (3.90%), showing the potential of using *Salicornia neei* in soils affected by salts.

The researchers[16]evaluated the absorption of Nitrogen ($N^{3-}$), Sodium ($Na^+$), Potassium ($K^+$), Calcium ($Ca^{2+}$) and Magnesium ($Mg^{2+}$) by *Salicornia ramosissima* (today *Salicornia neei*) grown in pots with saline soil and subjected to the treatments of: TW(water), T1 (desalinator reject), T2 (waste + 7g/NaCl), T3 (waste + 14g/NaCl) and T4 (waste + 21g/NaCl) monitored for four months. They showed that with the intermediate dose T3 (waste + 14g/NaCl) there was a better absorption mainly of Magnesium ($Mg^{2+}$).

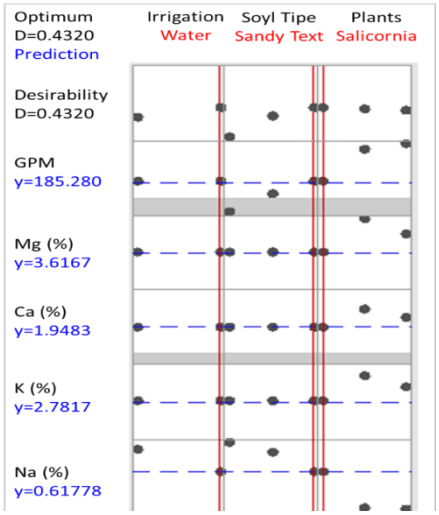



**Fig3.** *Results obtained for absorption of nutrients by Salicornia neei intercropped, or not, with small palm (Nopalea cochenillifera), in three different textures of soils and irrigated with water and desalinator reject*

## CONCLUSION

Based on the results obtained, it can be concluded that intercropped *Salicornia neei* and small palm (*Nopalea cochenillifera*) presented a better production of green and dry matter when irrigated with desalinator reject and cultivated in

the soil with sandy texture. *Salicornia neei* showed better absorption of sodium, potassium, calcium and magnesium in the soil with a sandy texture and irrigated with water. Therefore, the intercropping of *Salicornia neei* and small palm (*Nopalea cochenillifera*) can be favored by the nutrients provided by the halophyte.

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