Plant
2024, Vol. 12, No. 4, pp. 131-141
https://doi.org/10.11648/j.plant.20241204.16

Research Article

Effect of Saline Stress on the Growth and Physiological Behavior of Young Planting *Acacia nilotica* in Nursery and After Transplantation

Abib Fanta Chimene*, Hand Mathias Julien, Malla Dari Sidoine

Department of Biological Science, Faculty of Sciences, University of Maroua, Maroua, Cameroon

Abstract

This work consisted of studying the effect of saline constraint represented by different concentrations of NaCl (0, 2, 4, 8 and 11 g / l) at *Acacianilotica* on certain nursing parameters (germination, growth, biochemical and nutritional) and the survival rate one year after transplanting young clubs in field. The results obtained 14 days after seeding show that the germination rate falls below 40 g / l of NaCl and passes from 90% to 39.2% to 11 g / l of NaCl. After 3 months of stress, it is spring that the growth marked by the height, the diameter of the collar, the number of sheet and the foliar surface decrease as the NaCl concentration increases unlike ray biomass. Salinity has favored the accumulation of soluble, polyphenol, proline and total protein levels in the plant during the experimentation. Regarding the nutritional effect, NaCl negatively affects the nutritional scale of the plants. One year after transplantation, NaCl processed plantations have the best survival rates and the highest was obtained with 4 g / l of NaCl (89.61%). Thus, the submission of young *Acacia nilotica* plants to a salt strike of 4 g / l NaCl could allow to produce saltwoods for the salinity of the Sahelian zone of Cameroon and this fact contribute to the success of the reforestation campaigns by lower decreases of the mortality rates of transplantation.

Keywords

Acacia nilotica, Salt Stress, NaCl, Sahelian Area, Transplantation

1. Introduction

Anthropogenic activity is the main cause of many changes in the environment. Indeed, the growing populations use natural resources to meet their needs [1]. This pressure accentuates the degradation of natural resources mostly forest with consequently desertification and aridification of land, thus braking the plant production [2]. This situation is very pronounced in arid and semi arid regions, such as the far-north of Cameroon, because the precipitation associated with an important evaporation promotes the accumulation of salts in the ground [3]. Salinity is a major limiting factor for global agriculture [4]. The effect of salinity is generally manifested in most plants by a reduction in development [5]. This detrimental effect translates into morphological, physiological, molecular changes that negatively affect plant productivity [6, 7]. Indeed, according to [8], some salts can affect nutritional balance in plants if they are present in excessive concentration or in abnormal proportion. It is therefore imperative to seek solutions to combat

*Corresponding author: abibfany3@gmail.com (Abib Fanta Chimene)

Received: 10 October 2024; **Accepted:** 4 November 2024; **Published:** 26 November 2024

desertification while rehabilitating natural ecosystems and resolving the regeneration problems of some forest species in arid areas. As a result, the introduction of salt resistant plant species or induction of resistance in naturally existing species and high-socio-economic value such as *Acacianilotica*, is one of the solutions. This was therefore devoted to the study of the effect of salinity on the functioning of *A. nilotica* particularly on growth, biochemistry and physiology in order to identify the sole-to-cans sort of thrinity of this species.

2. Material and Method

2.1. Presentation of Study Area

This study was carried out in the greenhouse at the IRAD station (Institute for the development of the development of Maroua) (Latitude: 10 ° 36'35"n, Longitude: 14 ° 20'48'E), head of the region of the Far-north of Cameroon. This locality is governed by a tropical climate of a Sudano-Sahelian hot. It is ranging at average 700 mm railway per year [9]. with an average annual temperature of about 28 ℃, an important evaporation thus promoting the accumulation of salts in the ground [3, 10]. Its vegetation consists of grassy steppes and woody strata, consisting mainly of the thorny (Acacias, Faidherbia, Balanites), whose strong operation causes the scarcity of natural stands [11].

2.2. Material

The plant material was made of the *Acacia nilotica* seeds collected in Madjema (10 ° 35’37’’N, 14 ° 20’24’’E), a district of the city of Maroua in the district of Maroua I. The chemical material consisted of the salt of kitchen (NaCl) which has made it possible to constitute the saline watering water.

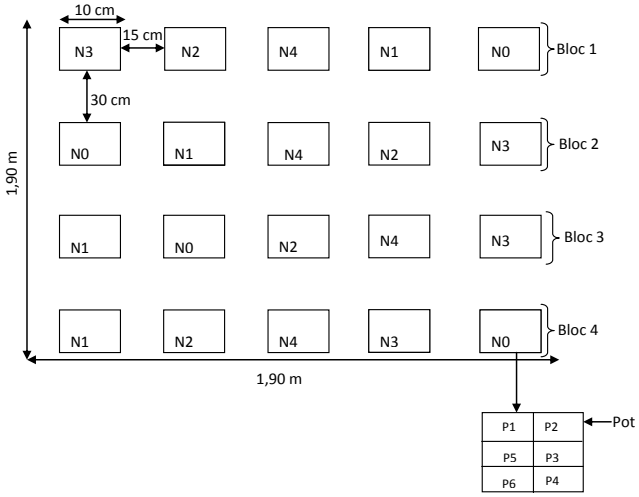
2.3. Method

Experimentaldevice

The experimental device used was a completely randomized 4-repeat block (block) and the treatment was consisting of 5 levels of salinity, namely:

1. Level 0 (N0) which was taken as a witness with a salmonity of 0.276 (cumulative salinity of the ground and water water without adding NaCl). These different levels of salinity were selected according to theMaillardClassification [12]:
2. Level 1 (N1) of salinity 1,187 after addition of 2 g of NaCl in 1 water;
3. Level 2 (N2) of salinity 2,478 after adding 4 g of NaCl in 1 water;
4. Level 3 (N3) of salinity 5,200 after adding 8 g of NaCl in 1 water;
5. Level 4 (N4) of salinity 7,095 after adding 11 g of NACL in 1 water.

Each block had five (05) lockers and each locker had 6 pots (Figure 1). The deposit departure by locker is the experimental unit. Each pot received two (02) seeds a total of 240 plants (5 levels of salinity x 4 blocks X 6 pots x 2 plants).



N0 =0g/l; N1= 2 g/l; N2= 4 g/l; N3= 8 g/l; N4= 11 g/l; P1…Pn= pots

Figure 1. *Experimental device.*

Collection and treatment of the culture ground

The earth used was taken in a rich-shaped mango manway park following the decomposition of the litter. This land is a clayous nature and taken at the surface of the surface layer (Table 1).

The soil thus taken from was cleared of harmful waste and then was mixed with the sand (30%). This mixture was then loaded in pots (18 cm deep and 15 cm in diameter) plastic at 2/3 of their capacity. These pots have hoses. The pots were then labeled and organized according to the experimental device, then, continuously watered to the current water both (02) days preceding the semi.

Table 1. *Framework of the ground used for nursery crop.*

Granulometry	Organic matter	Chemical components	Exchangeable cations
Clay (32%)	C (1.82%)	pH (6.3)	Ca (5.07 meq/100 g soil)
Limon (29.94%)	Total N (0.034)	Conductivity (99.85 µs)	Mg (1.58 meq/100 g soil)
Sand (38.06 %)	Total P (0.017)	CEC (8.63 meq/100g soil)	K (0.38 meq/100 g soil)
	C/N ratio (53.53)		

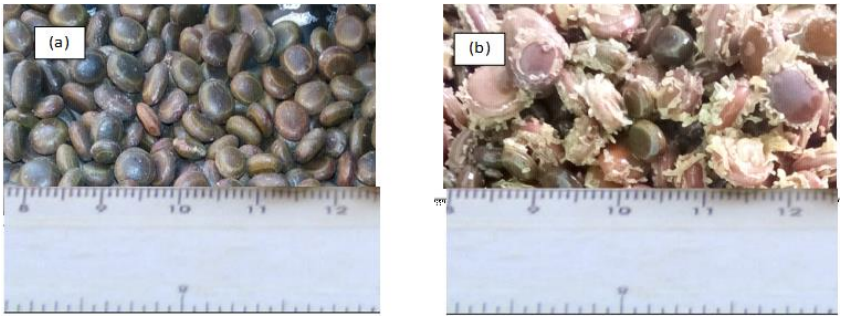


Figure 2. *Seeds collected (a) and pretreated by boiling (b) ofAcacia nilotica.*

Collection, pretreatment and seedling seeds

The seeds were manually collected on 10 feet of *Acacia nilotica*. These seeds were sorted and soaked in water before a boiling for 10 minutes and then preserved and allow to cool in a container for 48 hours [13]. This pre-creation operation of the seeds makes it possible to fray the extremely hard efficiency (Figure 2) and accelerate the dormant lift since they have a tough intensity. The seeds thus treated were put in pot at 1.5 cm deep.

Application of salt stress

Immediately after sowing, the pots were subjected to a salt treatment at concentrations 2, 4, 8 and 11 g/l NaCl. The control pot (0 g/l of NaCl) was watered only with running water whose electrical conductivity was 0.724 dS/m, according to the classification of Maillard [12], it is slightly saline water.

2.4. Measurement of Morphological, Biochemical and Physiological Parameters

2.4.1. DendrometricParameters

After planting the seeds, germination was monitored for two weeks and the germination rate was expressed as the ratio of the number of germinated seeds to the total number of seeds. Growth parameters were measured 60 days after sowing. The height of the plants was measured using a graduated ruler. The number of leaves was determined by manual counting of complete leaves with 50% of their green surface [14]. Root length was measured on 60 plants (i.e. 3 plants x 5 salinity levels x 4 blocks) previously uprooted and cleaned. This measurement was made from the collar to the apex of the main root using a graduated ruler [15]. The leaf area was measured on the 60 plants previously uprooted by the Win-Rhizo software (Régent Instruments INC. Canada) after scanning the leaflets and analyzing the images. To do this, three leaves located at different heights of the plant were marked and then measured [16]. The collar diameter was measured by a digital caliper. To evaluate the root and aerial biomass, the root and stem parts were placed in an oven at 65 ℃ for 72 hours to obtain the dry matter. The masses of dry matter constitute biomass.

2.4.2. Biochemical Parameters

In total, 5 biochemical compounds (total chlorophyll, total proteins, soluble sugars, prolin and polyphenols) were measured on fresh leaves well exposed to light from 60 uprooted plants (3 plants x 5 salinity levels x 4 blocks) before transplantation into the field (60 days afterseedlings). These contents were determined on. Thus, the total chlorophyll content was determined by fluorimetry according to the MA.800-Chlor.2.0 protocol. The total protein content was determined by the method of Bradford [17] and the soluble sugar content by the method of Cooper and McDaniel [18] after extraction by the method of Conroy et al. [19]. The prolin content was estimated according to the method of Ringel et al. [20], using the acid-ninhydrin reagent on an extract of the leaves (0.5 g), treated with NaCl in 3% sulfosalicylic acid. The polyphenol content was measured

with the Folin-ciocalteu reagent which in an alkaline medium reduces to tungsten and molybdenum oxide giving a blue color in the presence of polyphenol [21].

2.4.3. Physiological Parameters

The physiological parameters measured provide information on the assimilation of mineral elements. The K, Ca and Na contents were measured by a flame spectrometer (Perkin Elmer Analyst 400 model). Magnesium was measured by complexometry in the presence of EDTA. Phosphorus was measured colorimetrically at 850 nm using the cerulean-molybdic method [22]. Total nitrogen by titration after mineralization of the hot extract with sulfuric acid [23]. These assays were carried out on the fresh leaves of the 60 plants uprooted (3 plants x 5 salinity levels x 4 blocks) previously. These elements were only measured in the leaves because the leaves constitute the main site of metabolism in plants.

2.5. Field Transplant

After three (03) months in the nursery, the plants were put into the field. One year after transplantation, the survival rate was calculated. The transplanting of the plants was carried out on soil whose cultural history was millet. Two pots of each treatment per block were transplanted into the fields (i.e. a total of 64 plants: 8 treatments x 4 blocks x 2 pots). For transplantation, holes 15 cm deep and 5 cm in diameter were dug and watered the day before transplantation. During the digging, the soil most on the surface (0-10 cm) was kept to be put back after digging before planting the plants, this because this soil is rich in organic matter and should preferably be in contact with roots of the plant [24]. (Chapman and Allan, 1979). The plants were transplanted in the evening (5 p.m.) to allow them to acclimatize to the new environment before sunrise.

2.6. Data Processing and Statistical Analyzes

Statistical analyzes were carried out using Statigrapic 5.0 software. The ANOVA to see the variation between the means, the Duncan test to compare the means between them, the Excel software was necessary to draw the histograms and the curves.

3. Results and Discussion

3.1. Effect of Salinity on Germination Rate

The germination rate calculated 14 days after sowing (DAS) varies significantly ($P < 0.0001$) depending on the NaCl concentration (Figure 3). Indeed, the highest rate was obtained in the controls (0 mg/l of NaCl), i.e. 90%. This rate increases to 88% with 2 g/l of NaCl and 75% with 4g/l of NaCl. For concentrations of 8 mg/l and 11 g/l of NaCl, the germination rate is less than 50%. Thus, salinity negatively influences the germination of *A. nilotica* seeds.

The results relating to the germination rate thus obtained are in agreement with those obtained by Kheloufi [25] who showed a decrease in the germination rate with the increase in salinity on three (03) species of Acacia (*A. karroo*, *A. saligna*and *A. tortilis*). The mechanism of salinity on germination seems to be twofold: on the one hand salt seems to have a negative effect on the permeability of the plasma membrane by increasing the influx of external ions and the efflux of solutions from the cytosol [26], which is the origin ofthe increase in osmotic tension and a resulting increase in the imbibition time of the seeds, on the other hand the ions can have a toxic effect linked to a cellular accumulation of salts which would cause disturbances in metabolism, especially respiration [27]. Furthermore, Rejiliet al. [28] showed that osmotic effects result in the inability of seeds to absorb sufficient quantities of water to rebalance their critical hydration point in order to activate the germination process. Furthermore, according to AzevedoNeto et al. [29], high concentrations of sodium chloride can lead to the accumulation of Na+ and Cl- ions in the embryo, and thus contribute to the alteration of the metabolic processes of germination which modifies the activity of enzymes of metabolism of nucleic acids and proteins, interrupts hormonal balance and reduces the use of seed reserves or even death of the embryo due to excess ions [30].

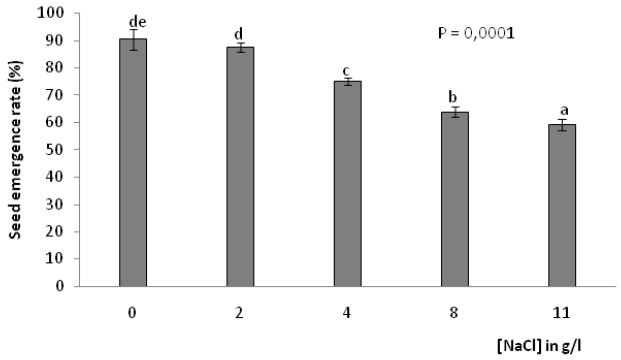


Figure 3. *Variation of the germination rate according to salinity.*

3.2. Effect of Salinity on Growth of *A. nilotica*

In general, salinity significantly influences ($p < 0.05$) the growth of young planting of *A. nilotica*. This influence is negative except the root system that is positively influenced (Table 2). Indeed, the height of the plant (PH) varies from 25.84 cm with 0 mg / l of NaCl at 21.49 cm; 23.38 cm, 15.95 cm and 14.74 cm respectively for the concentrations of 2, 4, 8 and 11 g / l of NaCl is a respective reduction rate of about 17%, 9%, 38% and 43% compared to the witness. As for the diameter of the collar (DC), this decrease is significant (p =

0.02) for concentrations of 8 and 11 mg / l of NaCl. These concentrations induce declines of 56 and 48% respectively compared to the witness. The values obtained with the concentrations 2 and 4 g / l of NaCl are not statistically different (p = 0.61) of those obtained with 0 mg / l of NaCl (2.88 cm). Similarly, PH and DC, the number of leave (NL) by plants and the foliar surfaces (FS) decrease as the NaCl concentration increases. NL and FS of the controlling plants are respectively 33 and 207.21 cm ². These values are reduced by more than 20% with 8 g / l of NaCl and more than 30% with 11 mg / l of NaCl. With regard to the length of the roots (LR) and the root biomass (RB) it appears that, the higher the NaCl concentration further increases the values of LR and SF increase. Lite of the witness (13.99 cm for 0 mg / N of NaCl) 23.23 cm to 4 g / l of NaCl, 25.55 cm with 8 g / l of NaCl and 27.15 cm with 11 g / l NaCl is the respective rates of respectively of 69%, 83% and 94%. BR of the witness is 0.38 g, this biomass passes at 0.51 with 2 mg / l of NaCl is an increase rate of about 34%, with 4 mg / l of NaCl, rated obtained is 0.56 g, or a rate of increase of about 47%. For concentrations 8 g / l and 11 g / l of NaCl, this rate of increase is greater than 80%. Unlike raud biomass, aerial biomass (AB) was negatively impacted by salinity because AB passes 1.52 g to 0 g / l of 1.42 g 2-g / l NaClNaCl is a reduction rate of about 7%. With 4 g / l of NaCl, AB drops about 9% (1.38 g). This reduction rate is more than 30% for concentrations 8 and 11 g / l of NaCl.

Table 2. *Effect of salinity on dendrometric parameters.*

[NaCl] (g/l)	PH (cm)	DC (cm)	NL	FS (cm ²)	LR (cm)	RB (g)	AB (g)
0	25,84 ±1,44e	2,88 ±0,11b	32,90 ±1,19d	207,21 ±23,14c	27,15 ±1,00d	0,38 ±0,03a	1,52 ±0,14c
2	21,49 ±0,84d	2,69 ±0,25b	30,55 ±1,30c	178,41 ±15,31b	25,55 ±0,50c	0,51 ±0,01b	1,42 ±0,05b
4	23,38 ±1,08c	2,62 ±0,53b	30,15 ±1,00c	169,05 ±12,53b	23,63 ±1,16b	0,56 ±0,03c	1,38 ±0,10b
8	15,95 ±0,68b	1,27 ±0,01a	25,23 ±0,42b	138,84 ±11,14a	14,54 ±0,69a	0,71 ±0,02d	0,97 ±0,01a
11	14,74 ±0,64a	1,49 ±0,01a	22,43 ±0,95a	138,74 ±12,78a	13,99 ±0,82a	0,88 ±0,01a	0,97 ±0,02a
F	235,91***	77,88*	176,03***	61,03**	522,7***	221,24***	97,63***

PH: Plant height; DC: diameter of collar; NL: number of leave; FS: foliar surface, LR: lenght of root; BR: Root biomass; AB: aerial biomass; F: coefficient of Fisher

The data obtained are consistent with the work done by Kheloufi et al. [31] on the plants of *Acacia karroo* and those of Kheloufi et al. [32] on *A. Tortilis*, *A. ehrenbergiana*and *A. dealbata*. Similarly, Karoune et al. [33] found a 42% reduction in the growth parameters. Albida in the context of salt stress. The reasons for this reduction can be explained by the inhibition of water absorption, reducing the translocation of cells, which would decrease the expansion of the tissues. Indeed, according to Ashraf and Harris [6], the pressure of turgescence is the engine of the elongation of the cellular wall of the primary growth of the plant. For leaflet parameters (leaf and leaf surface), the results are consistent with those obtained by Mamadou et al. [34] on *Jatrophascurcas* and Kheloufi [35] on Acacias in Algeria. According to Munns et al. [10], the expansion of leaves is severely inhibited by saline stress because, the new leaves are slowly developing and the sensescence of the olds accelerate. In addition, Parida and Das [36], falls that the thickness of the mesophill and the epidermis as well as the intercellular space decrease significantly in the handled sheets with the NaCl. The decrease in the leaf surface can also be explained by disturbances of growth rates in the tissues in growth, particularly abscissic acid and salt-induced cytokinines [37]. Thus, according to Zhu [38], this reduction in the growth of the different airlines would allow the plant to accumulate energy and resources to fight stress to deal with irreversible damage caused when the threshold value of the race concentration is reached. The positive effect on root growth was also raised by several authors [38-40]. According to these authors, under saline constraint, the plant spends more photosynthetic energy to maintain high water status and for root production for water search and / or reduction of water loss. So would also explain the increase in raid biomass under salin stress.

3.3. Effect of Salinity on Biochemical Parameters

The total chlorophyll content decreases significantly (p = 0.001) as the NaCl concentration increases from the start of 4 g / l of NaCl (Figure 4). Indeed, salinity has a reduction in chlorophyll content of about 35.23%, 49.91% and 62% respectively with 4, 8 and 11 g / l of NaCl compared to the chlorophyll content obtained in the control plants (5.8 mg / l). That said, salinity negatively impacts the chlorophyll content in young plantations of *Acacia nilotica.*

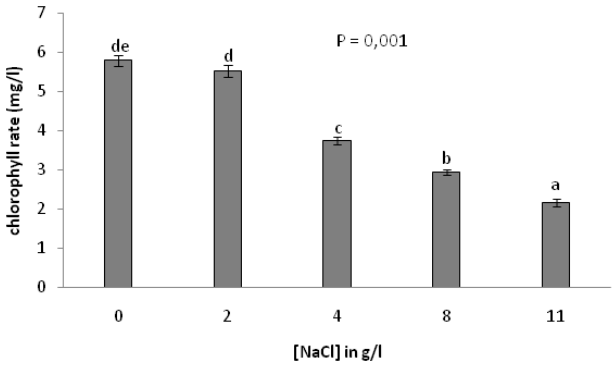


Figure 4. *Influence of salinity on total chlorophyll content.*

The negative influence of salinity on chlorophyll content was also reported in other acacia species like *Acacia amppiceps* [41] and *Acacia karoo* [35]. The reduction of chlorophyll content may be due to ionic stress marked by the inhibition of the absorption of certain elements as Mg and N_2 which are essential components in the structure of the chlorophyll molecule [42]. In addition, according to Garg and Singl [43], this reduction in the chlorophyll concentration in saline stress conditions can be attributed to the increase in activity of catalytic enzymes such as chlorophyllase and / or in the deterioration of the thylacoid membrane linked to a change in the ionic composition of the stromatic space [44, 45]. Unlike chlorophyll, the other dosed compounds (soluble sugars, polyphenols, prolin and total protein) significantly increase (p = 0.0001) with salinity (Table 3). This result is in agreement with those of several authors [4, 46, 47]. Indeed, salt stress is generally affected on plant physiology by an osmotic effect and nutritional imbalance [42]. According to Issaad [27], the maintenance of physiological processes under such situations is conditioned by the activation of various strategies, including the exclusion of toxic ions and / or the accumulation of organic substances that avoid the problem of dehydration. From Table 3, it appears that the more the salt concentration increase, the more the plants accumulate soluble sugars in their leaves. Indeed, the soluble sugar content is increased from 15.44g / 100g of MS (dry matter) into the witness to more than 25 g / 100g of MS in the sections placed exposed to high concentrations (11 g / l of NaCl) is a rate increase of more than 60%. However, at concentrations of moderate NACLs (2 – 4 g / l of NACL), the plants accumulate little soluble sugars in their leaves, or about 10 to 15% of the content contained in the control plants. These results are in the same direction as those obtained by AitHaddou et al. [48] for Citrus. Components mentioned that sugars improve the resistance to the osmotic stress induced by salt in plant, as soluble sugars are of particular importance because of their direct relations with physiological processes such as photosynthesis, translocation and breathing [49]. In fact, the increase in the concentration of soluble sugars leads an increase in osmotic potential of cytoplasm, which allows for greater sodium compartment in the vacuole [27]. In addition, according to Ashraf and Harris [6], soluble sugars could contribute more than 50% to the osmotic adjustment of glycophytes submitted with salinity surveys. In fact, soluble sugars provide major functions such as osmoprotectant, carbon storage, free radical trapping [50] and the maintenance of the water balance between cytoplasm and vacuole [27]. Salt treatment has favored the synthesis of proteins in *A. Niloticai*n a significant and positive way (p = 0.0006) because, the higher the concentration of NaCl, stronger protein content is high (Table 3). In fact, the total protein content is increased from 15.00 g / 100g of MS in the witness to 19.89 g / 100g of MS (an increase of 32.6%) in the plants subjected to a concentration of 2 g / l of NaCl. With 4, 8 and 11 g / l of NaCl, total ratio increases in the plants relative to the witness are respectively of 82.8%; 121.33% and 161.4%. The results thus obtained consist with those of Taffouo et al. [51] on *Mucunapoggei*and *Vignaunguiculata*; and Hand et al. [52] on *Talinumtriangulare*. The accumulation of total proteins seems to be due to the accumulation of dehydrin proteins in response to saline stress. These proteins play an important role in the stability of membrane proteins and in the osmotic adjustment [53]. Most of these proteins accumulate in the vegetative device (sheets or roots) of plants subjected to a water deficit, to saline stress or cold [27], and more precisely at the cytosol levels or the nucleus [54]. Their significant accumulation in response to cell dehydration suggests that dehydrins are involved as osmoprotectants, acting in synergy with solutes compatible in the stabilization of cytoplasmic structures [55]. In addition, to adapt to the osmotic pressure caused by saline stress, the plants accumulate a large amount of protein to achieve the osmotic adjustment. These will increase the osmotic pressure, restore the transciseness and protect the structures of the macromolecules against denaturation [54]. As for the effect of salinity on the accumulation of proline in the leaves of young planting of *A. nilotica*, it shows a significant and positive influence of salinity (Table 3). In fact, the prolium content increases as the NaCl concentration increases. This content is passed from 13.01g / 100g of MS in the control plants (0 g / l of NaCl) at 25.44 g / 100g of MS in the plants having received 2 g / l of NaCl then, in the presence of 4 g / l of NaCl, this content goes to 28.35 g / 100 g of MS. With 8 and 11 g / l of NaCl, prolin levels found in the plants are 30.83 and 36.57g / 100g of MS. The results found so are similar to those of AitHaddou et al. [48] and Setayesh et al. [56]. Several authors have bound the print of prolin to the tolerance of plants to salinity [4, 57, 58]. The accumulation of prolin would be attributed to the inhibitory effect of stress on its oxidation in the mitochondria [4], as well as on its incorporation into proteins [57]. In addition, according to these authors, the neosynthesis of the prolin would be triggered by the loss of the trugaceence due to salinity. It follows from the table 3 the salinity induces an accumulation of polyphenols. Indeed, the higher the NaCl concentration, the higher the polyphenol content increased. This content varies from 6.34g / 100 of MS (in witnesses) to 8,22g / 100g of MS

for 4g / L of NaCl and 9.11 g / 100g of MS for plants having received 11 g / l of NaCl. This increase in polyphenols facing salinity was also reported in several studies and at various species of plants such as *Pisumsativum* [59], *Lactuca sativa* [60] and *Moringaoleifera* [61]. This shows the antioxidant effect of this metabolite in the fight against oxidative stress generated by salinity. According to Macheix et al. [62], Prolin is very effective in the tolerance of plants to salt stress, so this compound plays a vital role in the balance and adaptation of the plant within its natural environment.

Table 3. *Effetof salinityon thecontent (g/100g de MS) of biochemical compounds in leavesof A. nilotica.*

[NaCl] g/l	Soluble sugar	Proteins	Prolin	Polyph énol
0	15,44 ±0,49a	15,00 ±0,67a	13,01 ±0,47a	6,34 ±0,42a
2	16,99 ±0,67b	19,89 ±0,56b	25,44 ±0,68b	7,45 ±0,50b
4	17,80 ±0,42c	27,42 ±0,50c	28,35 ±0,71c	8,22 ±0,18c
8	21,40 ±0,51d	33,20 ±0,42d	30,83 ±0,80d	8,77 ±0,46d
11	25,45 ±0,49e	39,21 ±0,42e	36,57 ±0,36e	9,11 ±0,39d
F	584,74***	411,85***	565,86***	34,19***

Table 4. *Effect of salinity on the accumulation of mineral elements in the leaves of A. Nilotica.*

[NaCl] g/l	K^+	Mg^{2+}	Cl^-	Na^+	Ca^{2+}	N
0	50,66 ±0,94e	7,33 ±0,82c	0,07 ±0,01a	4,22 ±0,63a	38,89 ±0,74e	43,43 ±1,07e
2	48,33 ±1,56d	5,22 ±0,78b	17,24 ±0,79b	19,98 ±0,67b	36,63 ±0,83d	38,12 ±1,39d
4	43,42 ±0,69c	4,67 ±0,47b	22,20 ±0,63c	24,41 ±0,51c	32,71 ±0,49c	35,01 ±0,82c
8	37,89 ±0,73b	3,89 ±0,57a	33,40 ±0,70d	32,82 ±0,59d	29,99 ±0,67b	31,31 ±0,63b
11	33,75 ±0,66a	3,87 ±0,55a	38,90 ±0,74e	37,74 ±0,81e	25,90 ±0,63a	23,90 ±0,88a
F	658,68***	42,73**	5605,56***	3556,76***	454,75***	544,73***

3.4. Effect of Salinity on the Assimilation and Accumulation of Mineral Elements

NaCl treatment induces a significant increase ($p < 0.001$) of the Na^+ and Cl and the decrease of K^+, Mg^{2+} and Ca^{2+} (Table 4). Indeed, the amount of k^{2+} increased from 50.66 (0 g / l of NaCl) to 33, 75 (11 g / l of NaCl) and that of Ca^{2+} VA of 38.89 (0 g / l of NACL) at 25.90 (11 g / l of NaCl). As for the amount of Mg^{2+} and N, their drop rate increases quickly and reaches 80% to 11 g / l of NaCl. Concerning about Cl- and Na^+, they accumulate enormously in the plants because from 2 g / l of NaCl, the amount quantity (0.07 for Cl- and 4.2 Na^+) of these larges about 90% clothing and 79% for Na^+. The negative influence of salinity on the absorption of the various dose elements was also raised by several authors [42, 51, 63]. Indeed, the absorption of the high concentrations of Na^+, Cl^- would generate a competition with the absorption of other ions. The accumulation of the Na^+ ions in the plant would limit the absorption of the necessary cations such as K^+ and Ca^{2+}. According to Chinnusamy et al. [64], there would be a competition between Na^+ and Ca^{2+} for the same apoplasmic fastening sites. In addition, the accumulation of the Na^+ and Cl^- ions at the level of the mesophilic leaves, would affect the growth and metabolism of the plant where NaCl damage the lipidic and protein structures of plasma membranes. Thus the presence of these ions disturbs the cell enzymatic activity mainly in the photosynthetic fabrics. This would explain why, the increase in the NaCl concentration is accompanied by a reduction in the concentration in Mg, K, N, and Ca in the plant. This nutritional imbalance would be a possible cause of growth cuts in plants subjected to saline stress. Thus, salinity also would have a negative effect on nutritional physiology of planting because, according to Maillard [12], salinity can affect nutritional balance in plants if the salts are present in excessive concentration or in abnormal proportion. Indeed, according to Levigneron et al. [65], the excessive presence of sodium, chloricic and boric ions may cause an increase in the

pH of the ground, which has an indirect effect on the impossibility of absorption of ferrous iron, phosphate, zinc and manganese essential for the growth of plants.

3.5. Variation of the Survival Rate a Year After Transplantation

One year after transplantation, it is shown that the saline treatment increases the survival rate of the field plants (Figure 5). Indeed, the lowest survival rate is obtained with 0 g / L of NaCl (45.70%), then follows the concentration 2 g / l (51.25%). The most effective concentration is 4 g / l because with this dose, the highest survival rate is 89.61%. Beyond this concentration, the survival rate falls, or 78.09% for 8 g / L of NaCl and 56.28 for 11 g / l of NaCl. The results thus obtained are closer to those of Cheikh et al. [66], on the anarcadier (*Western anacardium* L.), Labo et al. [67] on the *Elaeisguineensis* Jacq. The mortality of plant salin species is the result of a disturbance of water supply and inhibition of metabolism [68]. In addition, according to Genere and Garriou [69], this mortality is explained by a drying of terminal buds and stems, following a break in the sap columns (loss of hydraulic conductivity per cavitation). This high mortality rate at low concentrations (0 and 2 g / l of NaCl) and high (8-11g / N of NaCl) of NACL may be due to the deformation of the root system and the insufficient number of radicelines caused by saline stress. Our results corroborate with the Labo et al. [67], who claims that one of the causes of poor recovery is the poor quality of root systems of plants.

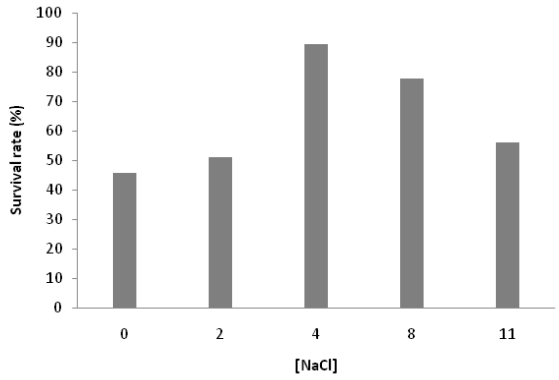


Figure 5. *Variation of the survival rate a year after transplantation of young planting.*

4. Conclusion

Through this work, we focused on the effect of saline stress on the growth and physiological behavior of young acadeciaotica nuts and nursing transplantation. It shows that salinity negatively affects the germination rate and the growth of the aerial part of the plants. As for the root part, it is positively affected. Regarding the fixed biochemical elements (soluble sugars, total proteins, prolin and polyphenol), their levels increase as the NaCl content increases. In the case of the effect of salinity on the assimilation and the accumulation of the mineral elements, it stems that NaCl induces an increase in the rate of the Na^+ and Cl^- and a decrease of the K^+, Mg^{2+} and Ca^{2+}. One year after transplantation, it is clear that the saline treatment increases the survival rate of the fields in the field but this survival rate falls below 40 g / l of NaCl. Thus, the most effective concentration of NaCl for the fine vigorous plants for the soil of the Sahelian zone of Cameroon is 4 g / l.

Abbreviations

IRAD	Agricultural Rechsearch Institute for Development
CGES	Environmental and Social Management Framework
DAS	Days After Sowing

Author Contributions

Abib Fanta Chimene: Conceptualization, Data curation Formal Analysis, Methodology, Writing – original draft

Hand Mathias Julien: Conceptualization, Funding acquisition, Investigation, Supervision

Malla Dari Sidoine: Investigation, Methodology, Resources, Writing – review & editing

Conflicts of Interest

The authors declare no conflicts of interest.

References

[1] Picouet M., (2001) « Population, Environnement et Développement » [Population, Environment and Development]. In Lery A.,Vinard P., ed. Population et developpement: Les principauxenjeux cinq ans après la conférence du Caire, Paris, Document et Manuels du CEPED, 12: 13-23.

[2] Abdelly C., (2004). Effet du déficithydrique sur la croissance et l'accumulation de la proline chez *Sesuviumportulacastrum*[Effect of deficit hydric on growth and prolinaccumulation in *Sesuviumportulacastrum]*. *Revue des régionsArides*, Tome 1, No. Spécial: 234-241.

[3] Lachhab, L., Louahla, S., Laamarti, M., et Hammani, K. (2013). Effect d'un stress salin sur la germination etl'activitéenzymatique de deux genotypes de *Medicagosatives* [Effect, of saline stress on germination and enzymatic activity in to two genotype of *Medicagosatives*]. *International Journal of Innovation and AppliedStudies*, 2(3), 511-516.

[4] Djerroudi, Z. O., Belkhodja, M., Bissati,S., et Hadjadj, S. (2010). Effet du Stress Salin sur l'accumulation de Proline chez deuxespècesd'Atriplexhalimus L. etAtriplexcanescens (Pursh) Nutt [Effect of saline stress on proline accumulation in two species of *Atriplexhalimus* L. et *Atriplexcanescens* (Pursh) Nutt]. European Journal of Scientific Research. vol. 41, n °2, pp 249-260.

[5] AlbouchiA.,Bejaoui Z. and El Aouni M. H.(2003). Influence of moderate or severe water stress on the growth of CasuarinaglaucaSieb. seedlings. *Sécheresse*, 14, 137-142.

[6] Ashraf M. and Harris. (2004). Potentialbiochemicalindicators of salinitytolerance in plants. *Plant Science*, 166: 3-6.

[7] ThourayaR'him, Imen T, Imen H, Riadh I, Ahlem B, Hager J. (2013). Effet du stress salin sur le comportementphysiologiqueetmétabolique de troisvariétés de piment (*Capsicum annuum* l) [Effect of saline stress on the physiological and metabolic behavior of three varieties of peppers (*Capsicum annuum*)]. *Journal of Applied Biosciences* 66, 5060–5069. https://doi.org//10.4314/jab.v66i0.95004

[8] Türkyilmaz B., YildizAkta L., Avni G. (2011): "Salinity induced differences in growth and nutrient accumulation in five barley cultivars", Turkish J. of Field Crops, 16, 84-92.

[9] Anonyme. (2007). Plan de développement de la Région de l'Extrême-Nord, Cameroun. [Development plan of the Far North Region of Cameroon]. 75-103.

[10] Munns, R., James, R., and Lauchli, A. (2006). Approaches to increasing the salttolerance of wheat and othercereals. *J. Exp. Bot*., 57, 1025-1043.

[11] CGES (Cadre de GestionEnvironnementaleetSociale). 2017. Rapport final. Pp 34-68.

[12] Maillard J., (2001). Le point sur l'irrigationet la salinité des sols en zone sahélienne. Risquesetrecommandations. Handicap International.[Update on irrigation and soil salinity in the Sahelian zone: Risks and recommendations]. 34 p.

[13] HamawaYougouda, Baye-Niwah Claudette, KepwaFils Bill Franck Steve etMapongmetsem Pierre Marie. (2020). Effet de Prétraitements sur la Germination des Semences de *Acacia senegal* (L.) Willd. (Mimosaceae) dans la Zone Sahélienne du Cameroun. [Effects of pretreatment on the germination of *Acacia senegal* seeds in the Sahelian zone of Cameroon]. *European Scientific Journal* 16: 3. 1857- 7431. https://doi.org/10.19044/esj.2020.v16n3p263

[14] KabongoTshiabukole. (2018); Evaluation de la sensibilité aux stress hydriques du maïs (*zeamays* l.) cultivedans la savane du Sud-Ouest de la RD Congo, cas de Mvuazi.[Evaluation of the sensitivity to water stress of maize (Zea mays l.) grown in the savannah of southwestern D. R. Congo, case of Mvuazi]Thèse de DoctoratPhd, Faculté des Sciences Agronomique. Université Pédagogiquenationale, 161p.

[15] Jeong-Ho, L., Kee-Jai, P., Bum-Keun, K., Jin-Woong, J., & Hyun-Jin, K. (2012). Effect of salinity stress on phenolic compounds and caro-tenoids in buckwheat (*Fagopyrumesculentum* M.). sprout. Food Chem, 135, 1065-1070.

[16] Konate N. M., (2010) Diversitéinterspécifiqued'efficienced'utilisation de l'eau des acacias sahéliensetaustraliens [Interspecies diversity of water-use efficiency of Sahelian and Australian acacia trees] Thèsepresentée pour l'obtention du titre de Docteur de l'Université Henri Poincaré, Nancy-I enBiologieForestière. 122p.

[17] Bradford M. M., (1976). A rapid and sensitive method for the quantitation of microgram quantities of protein utilizing the principal of protein-dye binding. *Anal. Biochem*. 72 248–254.

[18] Cooper G. R. and McDaniel V. (1970). The determination of glucose by the ortho-toluidine method (filtrate and direct procedure). *Standard Methods of clinicalchemistry*. 61: 159-170.

[19] Conroy J. P., Virgona J. M., Smillie R. M., Barlow E. W. (1988) Influence of droughtacclimation and CO_2 enrichment on osmoticadjustment and chlorophyll a fluorescence of sunflowerduringdrought. *Plant Physiol* 86: 1108-1115.

[20] Ringel, C., Siebert, S. and Wienhaus, O. (2003). Photometricdetermination of proline in quartz microplates: remarks on specificity. *AnalyticalBiochemistry*, 313: 167-169.

[21] Dewanto V. W. X., Adom K. K., Liu R. H. (2002). Thermal processingenhances the nutritional value of tomatoes by increasing total antioxidantactivity. Journal of AgricultureandFoodChemistry.50,310-3014.

[22] John MK. (1970). Colorimetricdetermination of phosphorus in soil and plant materialswithascorbicacid. *SoilSci*; 109: 214-20.

[23] Pauwels, J. M., Van Ranst, E., Verloo, M. and Mvondo, Z. A., 1992. AnalysisMethods of Major Plants Elements. PedologyLaboratoryManual: Methods of Plants and SoilAnalysis. Stock Management Equipment of Worms and Chemical Equipment. *PublicaAgricol*: 28. 15.

[24] Chapman, G. W., and Allan, G., 1979. Techniques de plantations forestières [Forest plantation techniques]. ETUDE FAO: FORETS. 96p.

[25] KheloufiAbdenour. 2019. Contribution à l'étude des effets de la sécheresse et du stress salin sur l'écophysiologie des espècesd'acaciaenAlgérie [Contribution to the study of the effects of drought and saline stress on the ecophysiology of acacia species in Algeria]. Thèse de doctoratenbiologie. Université de Batna 2, faculté des sciences de la nature et de la vie, département écologie et environnement. 136 p.

[26] Adem, G. D., Chen, G., Shabala, L., Chen, Z. H., and Shabala, S. (2020). GORK channel: a master switch of plant metabolism? Trends Plant Sci. 25, 434–445. https://doi.org/10.1016/j.tplants.2019.12.012

[27] Issaad G.,(2013). Statutnutritionneletplasticité de réponse aux stress chez un modèle végétale (*Triticumdurum*Desf.) [Nutritional status and plasticity of stress response in a plant model (*Triticum durum*Desf.)]. Thèse. Université Badj-Mokhtar. ANNABA.15-35.

[28] Rejili, M., Vadel, A. M., Guetet, A., Mahdhi, M., Lachiheb, B., Ferchichi, A. & Mars, M. (2010). Influence of Temperature&Salinity on the Germination of *Lotus creticus* (L.) from the Arid Land of Tunisia. *African Journal of Ecology*, 48: 329-337.

[29] AzevedoNeto A. D., Prisco J. T., Enéas Filho J., Lacerda C. F., Silva J. V., Costa P. H. A., Gomes Filho E. (2004). Effects of salt stress on plant growth, stomatalresponse and solute accumulation of differentmaizegenotypes. *Braz. J. Plant Physiol*. 16, 31–38.

[30] Hajlaoui H., Denden M., Bouslama M. (2007). Etude de la variabilitéinterspécifique de tolérance au stress salin du poischiche (*Cicer arietinum*L.) au stade germination. [Study of inter specific variability of tolerance to salt stress of chickpea (*Cicer arietinum* L.) at the germination stage]. *Tropicultura*25, 168-173p.

[31] Kheloufi, A., Mansouri, L. M. &Boukhatem, Z. F. (2017). Application and use of sulfuricacid to improveseed germination of three acacia species. *Reforesta*, 3: 1-10.

[32] Kheloufi, A., Chorfi, A. and Mansouri, L. M. (2016). Comparative effect of NaCl and $CaCl_2$ on seed germination of *Acacia saligna* L. and*Acacia decurrens*Willd. *International Journal of Biosciences*, 8(6): 1-13.

[33] Karoune S., Kechebar1 M., Halis Y., Djellouli A. etRahmoune C. (2016); Effet du stress salin sur la morphologie, la physiologie et la biochimie de l'*Acaciaalbida* [Effect of salt stress on the morphology, physiology and biochemistry of *Acacia albida*]. *Journal Algérien des RégionsArides*, 14: 73.

[34] Mamadou O., Kumar d., Diouf M., Nautiyal S. etDiop T. (2014). Effet de la salinitésur la croissance et la production de biomasse de deux provenances de Jatropha curcas L. cultivésenserre, [Effect of salinity on growth and biomass production of two provenances of *Jatropha curcas* L. grown in greenhouses]. *Int. J. Biol. Chem. Sci*., 8: 46-56.

[35] Kheloufi, A. (2017). Germination of seeds from two leguminous trees (*Acacia karroo*&*Gleditsiatriacanthos*) following different pre-treatments. *Seed Science & Technology*, 45: 1-4.

[36] Parida A. K. and Das A. B. (2005). Salt tolerance and salinityeffects on plants: a review. *Ecotoxicology and EnvironmentalSafety* (60), pp. 324-349

[37] Fahad S., Hussain S., Matloob A., Khan F. A., Khaliq A. and Saud S. (2015). Phytohormone and plant responses to salinity stress: A review. *Plant GrowthRegulation*., 75: 391-404.

[38] Zhu J. K., 2001. Plant salttoleranceReview. *Trends in Plant Science*, 6(2), 66-71.

[39] Bayuelo-Jimenez, J. S., Craig, R. and Lynch, J. P. (2002). Salinitytolerance of Phaseolusspeciesduring germination &earlyseedlinggrowth. *Crop Science*, 42(5): 1584-1594.

[40] Munns, R. (2002). Comparative physiology of salt and water stress. *Plant Cell Environ*, 25(2), 239–250.

[41] Theerawitaya C., Tisarum R., Samphumphuang T., Singh P., Cha-Um S., Kirdmanee C. et Takabe. (2015). Physio-biochemical and morphologicalcharacters of halophyte legumeshrub, *Acacia amplicep*sseedlings in response to salt stress undergreenhouse, *Frontiers in Plant Science*, 6: 630. 10p.

[42] Haoula. F., Ferjani. H., Benelhadji. S. (2007). Effet de la salinitésur la répartition des cations (Na^+, K^+ et Ca^{2+}) et de chlore (Cl-) dans les parties aériennes et les racines du Ray et du Chêne [Effect of salinity on the distribution of cations (Na+, K+ and Ca2+) and chlorine (Cl-) in the aerial parts and roots of Ray and Oak]. *Biotechnologie,Agronomie, Société etEnvironnement*, vol.11N °3: 235-244.

[43] Garg, N., andSingla, R. (2004). Growth, photosynthesis nodule nitrogen and carbon fixation in the chickpea cultivars undersalt stress. Braz. J. Plant Physiol., 16, 137-146.

[44] Al-Sobhi, O., Al-Zaharani, H., and Al-Ahmadi, S. (2006). Effect of salinity on chlorophyll and carbohydrate contents of *Calotropis procera* seedlings. Scientific Journal of King Faisal University. *Basic and Applied Sciences*: 7, 114-277.

[45] Mane A. V., Karadge B. A. and Samant J. S. (2010). Salinityinduced changes in photosynthetic pigments and polyphenols of *Cymbopogonnardus* (L.) Rendle. *Journal of Chemical and Pharmaceutical Research*, 2(3), 338-347.

[46] AitHaddouMoulouda M., Bousrhalb A., Benyahiaa H., Benazzoouza A. (2002). Effet du stress salin sur l'accumulation de la proline et des sucressolublesdans les feuilles de trois porte-greffesd'agrumes au Maroc [Effect of salt stress on the accumulation of proline and soluble sugars in the leaves of three citrus rootstocks in Morocco]. *Fruits*, vol. 57, 335–340.

[47] Chalbi N., Hessini K., Gandour M., Mohamed S., Smaoui A., Abdelly C., Ben Youssef N. (2013). Are changes in membrane lipids and fattyacid composition related to salt-stress resistance in wild and cultivatedbarley? *Journal of Plant Nutrition and Soil Science* 167, 138-147.

[48] Rahman M. S., Miyake H., Takeoka Y., Effects of exogenous glycinebetaine on growth and ultrastructure of salt-stressed rice seedlings (*Oryza sativa* L.), *Plant Prod. Sci*. 5 (2002) 33–44.

[49] Ildiko K. and Gabor G. 2000. Osmotic and salt stress inducedalteration in soluble carbohydrate content in wheatseedlings, *Crop Sciences* 40, p 482-487.

[50] Parida, A., Das, A., &Mittra, B. (2004). Effects of salt on growth, ion accumulation, photosynthesis and leafanatomy of the mangrove, (*Bruguieraparviflora*). *Trees-Structure and Function*, 18, 167-174.

[51] Taffouo, VD.,Djiotie, N. L., Kenne, M., Din, N., Priso, J. R., Dibong, S., Akoa, A. (2008). Effect of salt stress on physiological and agronomiccharacteristics of three tropical cucurbitspecies. *Journal of AppliedBioscience* 10, 434-441.

[52] Hand Mathias Julien, Nouck Alphonse Ervé, Nassourou Antoine Maina, Abib Fanta Chimene, TonfackLibert Brice, Taffouo Victor Désiré, Youmbi Emmanuel. (2022). Influence of salt stress on growth, leaf pigmentation, ionic distribution and metabolites accumulation of *Talinumtriangulare* (jacq.) willd. Leafyvegetables as affected by differentcassavapeellevels. *Journal of Advance Research in Food, Agriculture and Environmental Science* Volume-8 | Issue-9: 2208-2417
https://doi.org/10.53555/nnfaes.v8i9.141

[53] Svensson (2001). Fonctionnalstudies of the role of plant dehydrins in tolerance to salinitydessication, Epsilon dissertation and graduatethesis archives dep of plant, *Biology acta*, University agricultural SueciaeAgraria, 259. p 68-96.

[54] Le Rudulier D. (2005); Osmoregulation in rhizobia: The key role of compatible solutes. *Grain Leg*., 42: 18 - 19.

[55] Hayoun H., (2013). Etude comparative de l'accumulation des déhydrinesetmécanisme de tolérances du stress hydrique chez quelquesvariétés de blédur (*Triticumdurum*Desf.) [Comparative study of dehydrin accumulation and mechanism of water stress tolerance in some durum wheat varieties (*Triticum durum*Desf.)]. Thèse, Université Mentouri, Constantine Faculté de biologie Département de Biologie Végétale et Écologie 36-37.

[56] Setayesh M. Z., khajeh H., Bahabadi S. E. and Sabbagh S. K., 2012. Changes on proline, phenolic compound and activity of antioxidant enzymes in *Anethumgraveolens* L. undersalt stress. (V. Publications, Éd.) *International journal of Agronomy and Plant Production*, 3. 710-715.

[57] Abraham, E., Rig, G. S., Nagy, R., Koncz, C., and Szabados, L. (2003). Light-dependent induction of proline biosynthesis by abscisicacid and salt stress isinhibited by brassinosteroid in Arabidopsis. *Plant MolecularBiology*, 51, 363-372.

[58] Ashraf, M., Foolad, M. R. (2007). Roles of glycine betaine and proline in improving plant abiotic stress resistance. *Environ. Exp. Bot*.59: 206-216.

[59] Noreen Z. and Ashraf M., 2009. Assessment of variation in antioxidativedefense system in salt-treatedpea (*Pisumsativum*) cultivars and its putative use as salinitytolerance markers. (Elsevier, Éd.) *Jounal of plant physiology* (166), pp. 1764-1774.

[60] Mahmoudi, H., Huang, J., Gruber, M., Kaddour, R., Lachaal, M., Ouerghi, Z., &Hannoufa, A. (2010). The impact of genotype and salinity on physiologicalfunction, secondarymetabolite accumulation, and antioxidativeresponses in lettuce. *J. Agric Food Chem*, 58, 5122–5130.

[61] Nouma, W., Siddiqui M., Basra S., Khan R., Gull T., Olson M. &Munir H. (2012). Response of *Moringaoleifera* to saline conditions. *Int. J. Agric. Biol*. (14), pp. 757-762.

[62] Macheix, J., Fleuriet, A., et Jay-Allemand, C. (2005). Les composésphénoliques des végétaux [Phenolic compounds in plants]. Italie*: Edition*Lausame. 183 p.

[63] Lamia Hamrouni, Mohsen Hanana, ChédlyAbdelly, AbdelwahedGhorbel. (2011). Exclusion duchlorure et inclusiondu sodium: deuxmécanismes concomitantsde tolérance à la salinité chez la vignesauvage*Vitisviniferas*ubsp. Sylvestris (var.'Séjnènè) [Chloride exclusion and sodium inclusion: two concomitant mechanisms of salinity tolerance in wild grapevine *Vitisvinifera* subsp. sylvestris (var. 'Séjnènè)]. *Biotechnol. Agron. Soc. Environ.*15(3),387-400.

[64] Chinnusamy V., Jagendorf A. and Zhu J. K. (2005). Understanding and improvingsalttolerance in plants. *Crop Science* (45). 437-448.

[65] Levigneron A., Lopez F., Vansuyt G., Berthomieu P., Fourcroy P. et Cassedelbart F. (1995). Les plantes face au stress salin [Plants facing salt stress]. *Cahiers Agriculture*, 4: 263-273.

[66] CheikhOumarSamb, Dethie Wade, Elhadji Faye etMouhamadouMoustaphaDiaw (2020). Effet du stress salin sur la croissance de quatre provenances d'anacardier (*Anacardiumoccidentale L.*) en milieu semicontrôlé[Effect of salt stress on the growth of four cashew (Anacardiumoccidentale L.) provenances in a semi-controlled environment], VertigO - la revue électroniqueen sciences de l'environnement, Volume 20 numéro 2. https://doi.org/10.4000/vertigo.28462

[67] Labo, A., D. Sané, S. D. Ngomet L. E. Akpo (2016). Effet du sel sur le comportement des jeunes plants de palmier à huile (Elaeisguineensis Jacq.) enBasseCasamance [Effect of salt on the behavior of young oil palm plants (Elaeisguineensis Jacq.) in Lower Casamance], *Int. J. Biol. Chem. Sci*. 10(3), pp. 1312-1328.

[68] Benmahioul B., Danguin F., etKaidHarche M. (2008). Effet du stress salin sur la germination et la croissance in vitro du pistache (*Pistaciavera* L.) [. Effect of salt stress on germination and in vitro growth of pistachio (*Pistaciavera* L.)]Université AbouBekrKaïd. Tlemcen, Algerie. ComptesrendusBiologie*Agronomie*.331(2), 164-170.

[69] Gérard Beno îetGarriou Didier. (2005). Le dessèchement des plants entre l'arrachageet la plantation: résultatsd'uneétude sur trois essences forestières [Desiccation of seedlings between uprooting and planting: results of a study on three forest species]. *Forêt-entreprise* 161. 58-60.