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Effects of Soil Salinity on Agronomics Performances of Onion (*Allium cepa* L.) Varieties Cultivated in Tahoua Region, Niger

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Abstract

Soil salinity is a major constraint for irrigated agriculture, particularly in vegetable crop production such as onion crops. The main objective of this study is to evaluate the effects of soil salinity on the agronomic performance of onion varieties cultivated in the Tahoua region of Niger country. The study, conducted using block factorial design on soil pots, tested 3 varieties of onion (V1=local variety, V2=Perma variety, and V3= purple Galmi variety) with four (04) levels of soil electrical conductivity, EC (S0=control soil; S1=soil with EC of 4 dS/m, S2=soil with EC of 8 dS/m, and S3=soil with EC of 12 dS/m) to assess growth of onion plants as well as biomass and bulb yields. The results showed that the number of leaves, height, and diameter of onion plants decreased with increasing soil salinity levels under all varieties. Furthermore, an early cessation of growth evolution by plant wilting was observed on soil with high salinity (S3, CE=12 dS/m) at 60, 48, and 56 days after transplanting (JAR) under V1, V2, and V3 respectively. In addition, onion bulb yield, between 896 and 8000 kg/ha, decreases significantly with the increase in soil EC. Compared to control soil salinity (0.68 dS/m), an increase in soil salinity levels (3-16 dS/m) caused a reduction in onion bulb yield of 43 to 88%, particularly under local (V1) and Galmi violet (V3) varieties. Under local variety, bulb yield under control soil (7832.0 kg/ha) is respectively 3.2 and 8.7 times higher than that under S1 (2406.2 kg/ha) and S2 (896.4 kg/ha). However, V2 appears to be more tolerant to soil salinity than V1 and V3 in plant growth and bulb production. Thus, this study shows that soil salinity is a threat to onion crop production in Niger.

Keywords

Soil degradation, soil salinity, vegetable crops, onion crops, Niger

1. Introduction

Soil salinity is a major environmental constraint that reduces arable land, as well as plant production in the world [1-4]. Each year around 1.5 million hectares of irrigated land, i.e., 800 million hectares worldwide, including 40 million hectares in West Africa [5, 6], are affected by soil salinization [7] causing a decrease of 10% in global food production [8, 9]. The process of soil salinization, particularly due to anthropic activities, is accelerated especially in arid and semi-arid zones, because of high temperatures, restricted drainage, and low precipitation to leach soluble salts into soil deep layers [10-14]. In Niger, soil salinization is increasingly observed in the valleys which represent the majority of irrigated land. Thus, several studies showed the existence of soil salinization processes in irrigated areas of Niger River valleys, Tarka Valley, Maggia Valley, and Dallols Bosso [15-18]. These studies reported that soil salinization processes are mainly accelerated by uncontrolled irrigation which causes the logging water table and allows salts to concentrate in upper soil layers under the effect of high evaporation.

Soil salinity leads to osmotic stress which limits water and nutrient uptake by plants and consequently a reduction in plant growth [19-21]. However, the response to salt stress depends on plant species, plant cultivars, salt concentration, growing conditions, and development stage of the plant [21]. Furthermore, within the same species, substantial variation in salt sensitivity can appear between varieties as reported in pepper [22], okra [21], and wheat [23].

The vegetable crops are strategic commodities both to improve food security and also to reduce food product imports [21]. The onion (*Allium cepa* L.) is the second most cultivated vegetable crop in the world after the tomato. In Niger, onion is the first cultivated vegetable crop with an annual production estimated at 1 212 279.39 tonnes, generating an income of around 47 billion FCFA [24-25]. In Niger, several varieties of onion are cultivated in different regions but the "*Galmi violet*" variety is the most cultivated variety in the Tahoua region [26]. In the Tahoua region of Niger, onion production, which is generally practiced in valleys and/or lowlands by irrigation systems, is a very important activity of small producers, particularly during the dry season. In this Tahoua region, onion production is estimated at 788.206 tonnes per year with an average yield of 38 tonnes/ha, i.e., 65% of national production [25].

However, in these irrigated areas, signs of soil salinization are increasingly appearing on the soil surface, like in irrigated areas of valleys such as the Niger River valley [15, 18]. This soil salinization could have negative consequences on vegetable crop production such as onion crops, and the impacts on agronomic performance of this crop have not yet been studied in Niger. Although, salt tolerance can vary between species and between varieties [21]. Thus, the identification of salt-tolerant varieties and genotypes, capable of reducing the depressive effects of soil salinity on yields, can certainly improve agricultural production. The objective of this study is to evaluate the effects of soil salinity on the agronomic performance of different onion varieties cultivated in the Tahoua region.

2. Methods

2.1 Study site

The study was conducted on the experimental site of the Faculty of Agricultural Sciences (FSA) of Djibo Hamani University of Tahoua. It is located in commune 1 of Tahoua city at 2 km of southwest of the University (Figure 1). It is positioned on the lower glacis with very sparse vegetation. The climate of the area is Sahelian characterized by two main seasons: i) a rainy season of approximately 4 months (from June to October) and a dry season from October to May.

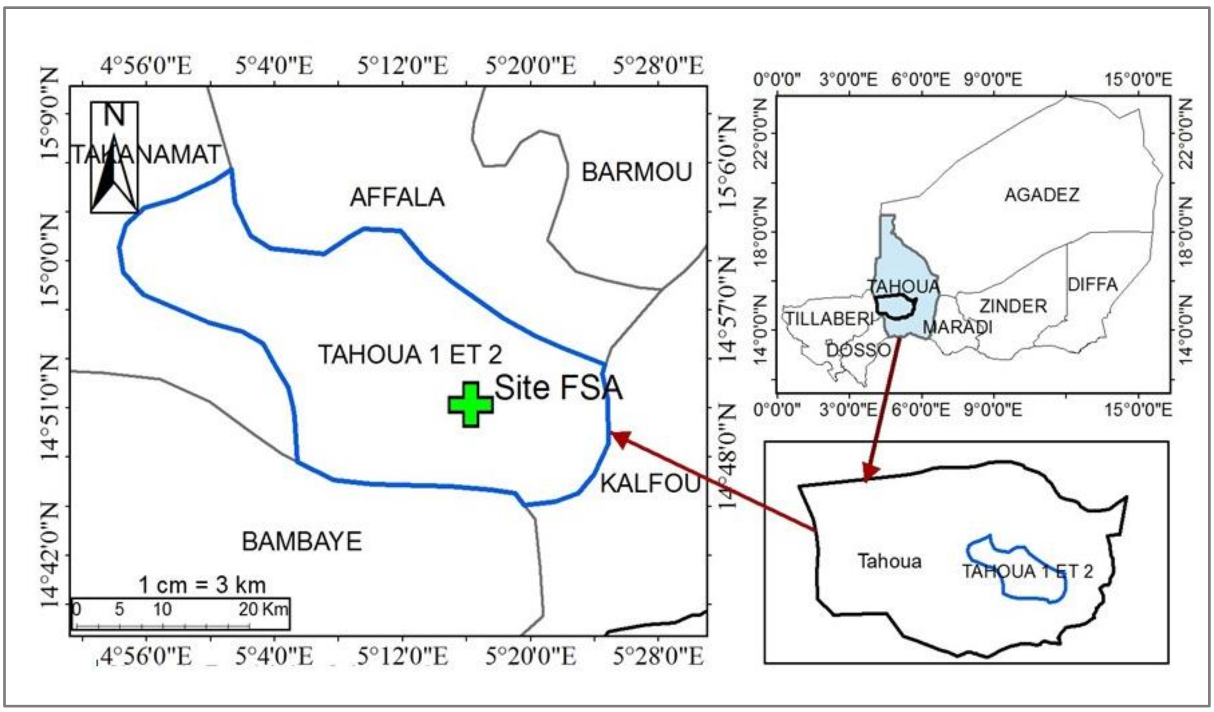

Figure 1. Location map of the experimental site of the Faculty of Agricultural Sciences of Tahoua (FSA).

The soil in the study site is a fluvisol characterized by a sandy-silty texture, low content of organic matter (0.45%), of total phosphorus (34.48 ppm), and assimilable phosphorus (14.9 ppm) (Table 1). Furthermore, the soil is moderately acidic (pH= 5.4) and has a very low salinity with an electrical conductivity of saturated paste (EC) of 0.68 dS/m.

Table 1. Physico-chemical composition of soil of study site

Soil texture (%)			Organic matter			Soil salinity		Phosphorus (meq/100g)	
Clay	**Sands**	**Silt**	**N (%)**	**C (%)**	**C/N**	**pH**	**CE (dS/m)**	**Total**	**Assim.**
12.28	76.56	19.34	0.04	0.45	11.25	5.19	0.68	34.48	14.9

2.2 Plant materials

The plant material used in this study was composed of three (03) varieties of onion, namely the local variety (V1), the Prema variety (V2), and the Galmi violet variety (V3). The main characteristics of these varieties are presented in Table 1. Indeed, the vegetative cycle of the crop varies from 120 to 170 days depending on the varieties. The Violet Galmi variety has a relatively long cycle (160-170 days) with a potential yield of 50-55 t/ha while the local variety appears to be earlier (120-140 days) with a potential yield of 40-50 t/ha [27].

Table 2. The main characteristics of the three onion varieties used in the experiment

Varieties	Provenance	Duration of growing cycle (day)	Potential yield (t/ha)
Locale	Tahoua	120-140	40-50
Prema	France	140-150	50-60
Violet de Galmi	Tahoua	160-170	50-55

2.3 Experimental design

The experimental design of the study was factorial block with 3 replications composed of onion varieties (main factor) in three (03) modalities (V1=Local variety, V2=Prema variety and V3=Violet de Galmi variety) and the soil salinity levels (secondary factor) in four (04) levels of soil electrical conductivity (EC) (S0=control soil with EC of 0.68 dS/m, S1= soil with EC of 3 dS/m, S2=soil with EC of 8 dS/m and S3=soil with EC of 16 dS/ m). Thus, the study's experimental design was composed of 12 treatments in three repetitions.

The treatments were installed on soil pots reconstituted from soil collected in a 0-30 cm layer of soil study site. Indeed, collected soil was dried and introduced in the pots (15 L. plastic buckets) according to 1.3 t/m^3 of apparent density (i.e 20 kg of soil per pot). A basic fertilization was applied in the pots at a dose of 300 g per pot of compost before crop planting.

At the beginning of the experiment, soil EC levels of S1, S2, and S3 treatments were obtained by saturating soil in the pots with a saline solution according to the concentration of 2.10, 4.95, and 9.9 g of NaCl per liter of water respectively. The volume of salinized water to saturate soil in the pots was estimated from the bulk density.

2.4 Crops production

The onion plants were previously grown in the nursery for 45 days in plots of 3 m^2 for each variety on the study site. After this nursery phase, 4 plants were transplanted into each pot. The pots are irrigated uniformly with borehole water (CE=0.26 dS/m) 2 to 3 times per week. The chemical fertilizer NPK (15-15-15) was applied according to a dose of 10 g per pot respectively 15 and 45 days after transplanting.

2.5 Data collection

The measurements and observations were performed weekly to collect data on the plant's height, the plant's diameter, and the number of plant leaves. The harvest was performed after the maturity of onion bulbs, assessed by the fall of plant aerial biomass. Thus, the harvest time varies depending on the variety cycle. The harvest consisted to a systematic cut of plants on each pot, including the biomass and bulbs. The yields of fresh biomass and fresh bulbs were evaluated by treatment and by repetition.

2.6 Statistical analysis

The analysis of variance (ANOVA) was performed with agronomic parameters collected during the experiment using XLSTAT software, version 2016 to evaluate the influence of different treatments on growth and yields of the different onion varieties. When a significant difference exists between the treatments, the ANOVA is completed by comparing means according to the Fisher test at the 5% threshold. In addition, the correlation test (Person at the threshold of 5%)

was performed to establish the relationships between the soil salinity (EC) and the agronomic parameters of onion crops, notably bulbs, and fresh biomass yields, the plant height, the plant diameter and the diameter of onion bulbs.

3. Results

3.1 Evolution of the height of onion plants

The plant height varies from 5 to 65 cm and increases over time under all varieties and all soil salinity levels (Figure 2). However, an early cessation of plant growth evolution was observed under S3 on soil with high soil salinity level (S3, CE=12 dS/m) following the plants wilting at 60, 48, and 56 days after transplanting (JAR) respectively for V1, V2, and V3. The general trend shows that plants of the Prema (V2) variety appear to be longer than those under V1 and V3, especially at the advanced growth stage. The increase in height plants over time is greater with the low soil salinity levels (S0 and S1) than with the high soil salinity levels (S2 and S3) under all varieties except the Prema variety (V2) where the plants under S2 were longer than under S0.

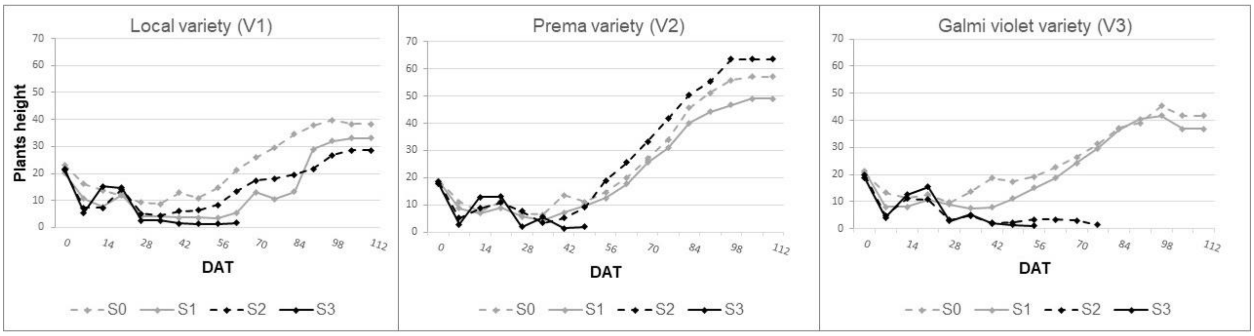

Figure 2. Temporal evolution of the plant height of onion crops under soil salinity levels and varieties (V1=Local variety, V2= Prema variety, V3=Violet de Galmi variety, S0= control soil, S1= soil with EC of 3 dS/m, S2= soil with EC of 8 dS/m, S3=soil with EC of 12 dS/m).

At 111 Days After Transplanting (DAT), the onion plants were significantly higher under control soil (S0) than under S1 and S2 for all varieties except the Prema variety where the difference is not significant between S0 and S2 (Figure 3). At this date (111 DAT), onion plants are 30 to 55 cm high under V1 and V3 while they are 50 to 65 cm long under V2 (Figure 3).

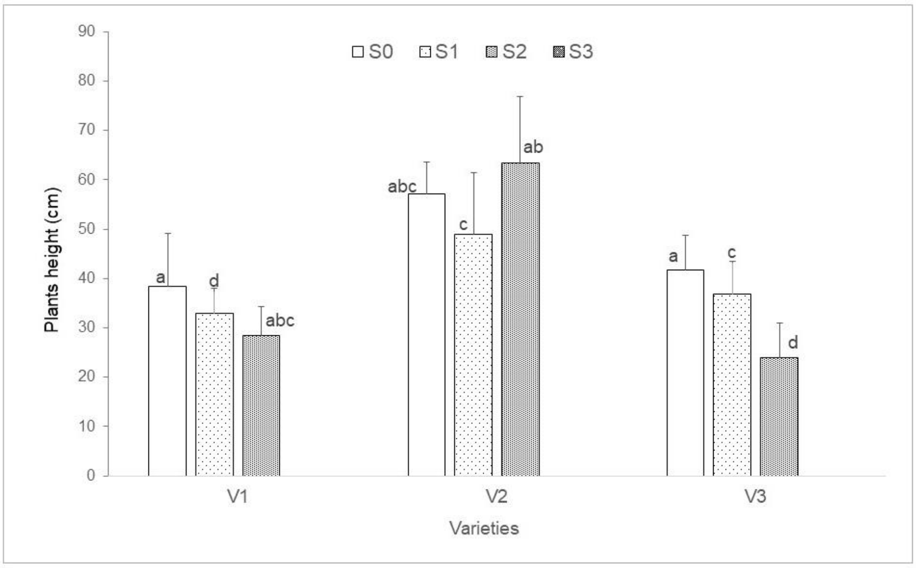

Figure 3. Variation in plant height under soil salinity levels and varieties at 111 Days After Transplanting (DAT) (V1=Local variety, V2 = Prema variety, V3 =Violet de Galmi variety, S0= control soil, S1= soil with EC of 3 dS/m, S2= soil with EC of 8 dS/m, S3=soil with EC of 12 dS/m. The bars represent the means standard deviations. The histograms assigned by the same letter are not statistically different according to LSD test with 5% threshold).

3.2 Evolution of plant diameter of onion crops

Figure 4 shows that the stem diameter of onion plants, between 2 to 19 cm, increases over time under all soil salinity levels and under all varieties. Following the plant's wilting, early cessation of stem growth was observed under S3 at 60, 49, and 56 DAT respectively under V1, V2, and V3. The growth of plant stem over time appears to be greater under S0 and S1 than under S3 and S4 for all varieties except under the Prema variety (V2) where S2 has the largest diameter than S0, especially with advanced growth stage.

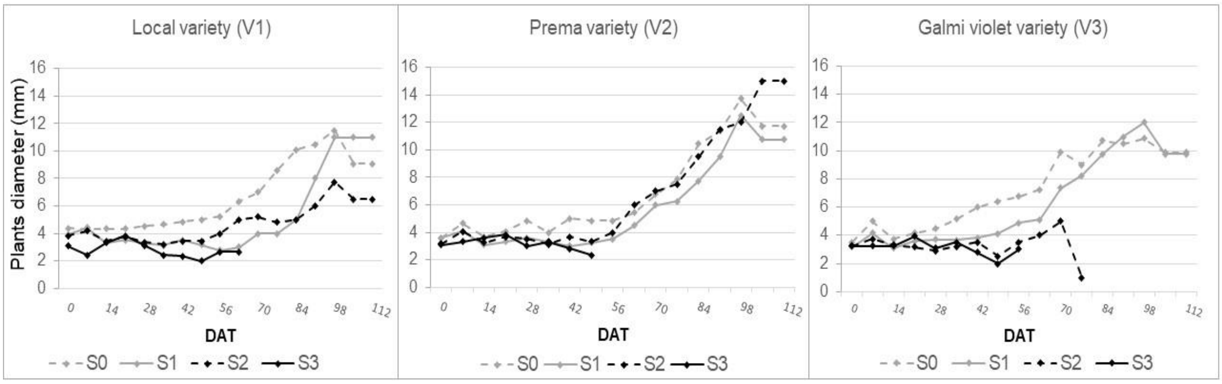

Figure 4. Temporal evolution of the diameter at the collar of onion plants according to the level of soil salinity and according to the varieties (V1=Local variety, V2= Prema variety, V3=Galmi Violet variety, S0= control soil (EC=0.68 dS/m), S1= soil with EC of 3 dS/m, S2= soil with EC of 8 dS/m, S3=soil with EC of 12 dS/m).

3.3 Changes in the number of plant leaves

Figure 6 shows that the number of plant leaves, between 1 to 12, increases over time under all soil salinity levels and under all varieties. However, early cessation of plant growth was observed at 59, 49, and 56 days after transplanting (DAR) respectively under V1, V2, and V3. The general trend shows that the onion plants of the Prema variety (V2) produce more biomass than that of the local variety (V1) and Galmi violet variety (V3). The increase in the onion plants' biomass over time is higher greater with the low soil salinity levels (S0 and S1) than with the high soil salinity levels (S2 and S3) under all varieties except under the Prema variety (V2) where the number of plants leaves under S2 is greater than under S0.

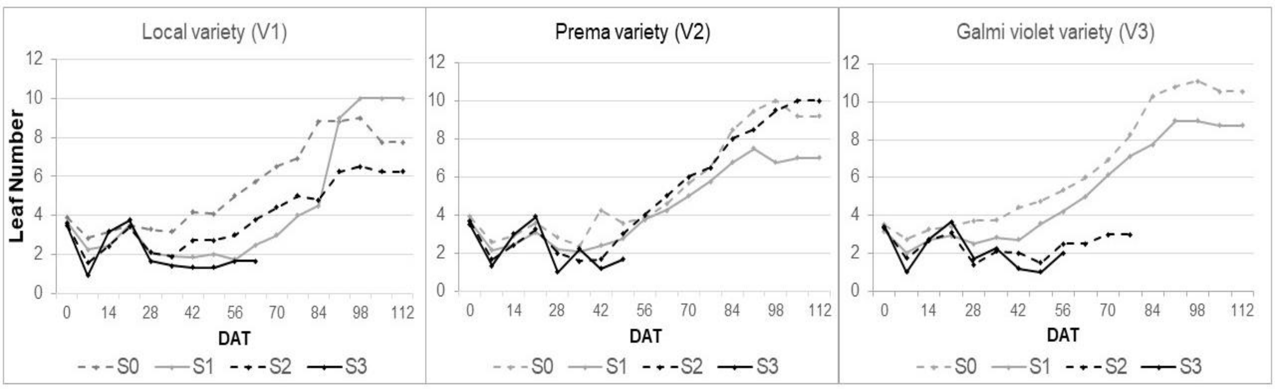

Figure 5. Temporal evolution of the number of leaves according to soil salinity levels and onion varieties (V1=Local variety, V2= Prema variety, V3=Galmi Violet variety, S0= control soil (EC=0.68 dS/m), S1= soil with EC of 3 dS/m, S2= soil with EC of 8 dS/m, S3=soil with EC of 12 dS/m).

3.4 Change in onion bulb size

The bulb's diameter is between 28 and 48 mm according to onion varieties and soil salinity levels (Figure 7). Indeed, the general trend shows that bulb diameter decreases with soil salinity levels under all varieties except under the Prema variety (V2) where the onion bulbs were bigger under S3 than under S1 and S2. However, no significant differences were found between soil salinity levels under all varieties.

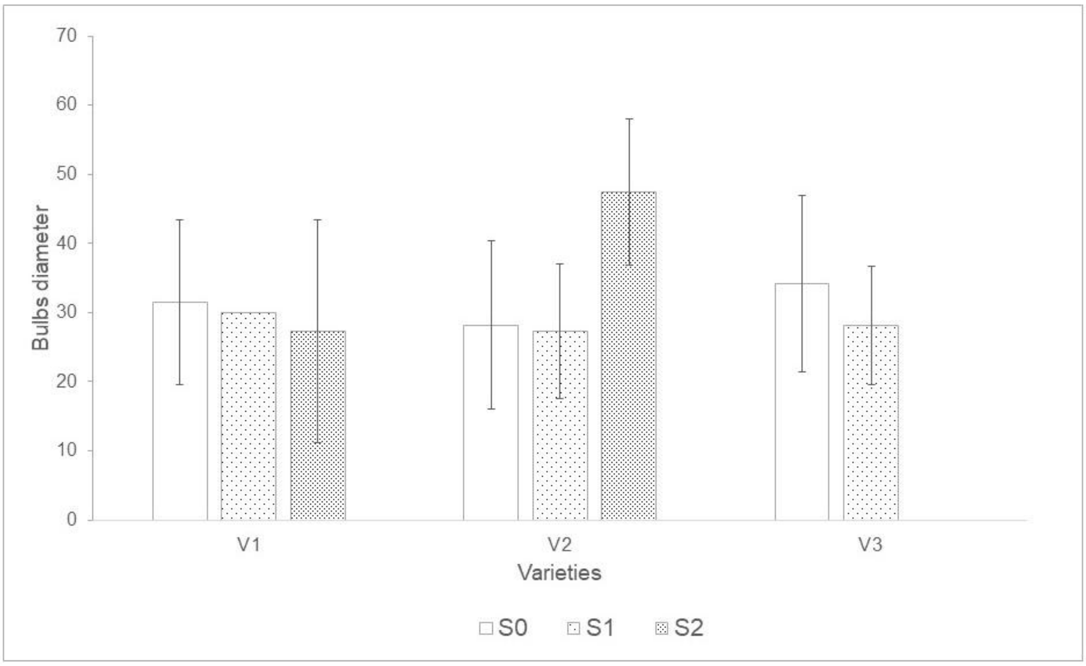

Figure 6. Bulb diameter according to different varieties under different soil salinity levels (V1=Local variety, V2= Prema variety, V3=Violet de Galmi variety, S0= control soil (EC=0.68 dS/m), S1= soil with EC of 3 dS/m, S2= soil with EC of 8 dS/m, S3=soil with EC of 12 dS/m. The bars represent the means standard deviations).

3.5Changes in onion biomass yields

The yield of onion fresh biomass, between 1415 and 8303 kg/ha, is significantly higher under control soil (6180.7 kg/ha) than that under S1 (3391.1 kg/ha) and S2 (3391.2 kg/ha) with local variety (V1) (Figure 8). This same trend was observed with the Prema variety and Galmi violet variety although no significant differences were found between soil salinity levels. However, under the Prema variety, the yield of onion fresh biomass under S2 (5850.4 kg/ha) is slightly higher than under S1 (4523.5 kg/ha) without the difference being significant.

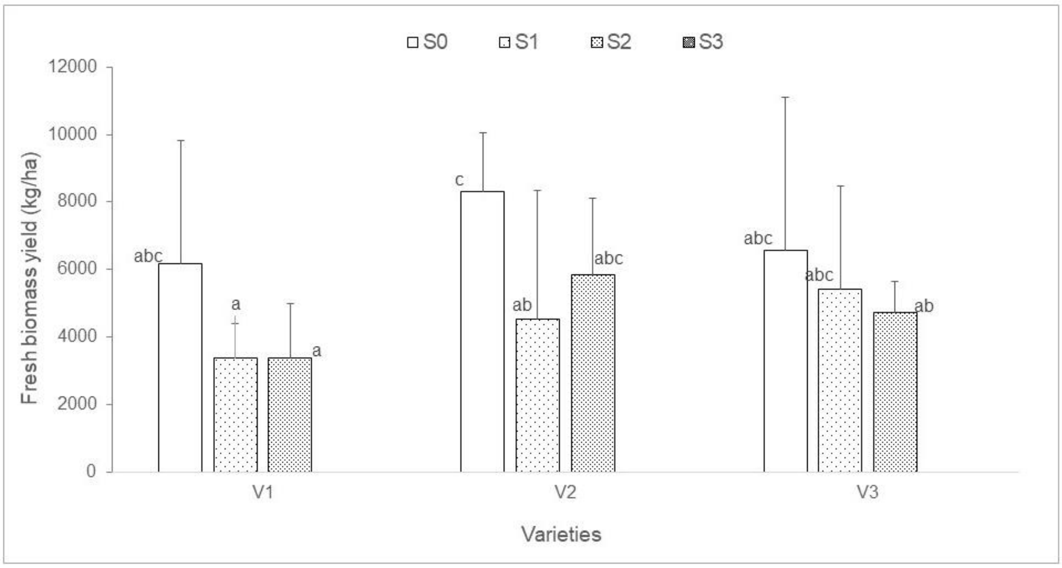

Figure 7. Variation in fresh biomass yield of onion crops under soil salinity level and varieties (V1=Local variety, V2= Prema variety, V3=Violet de Galmi variety, S0= control soil, S1= soil with EC of 3 dS/m, S2= soil with EC of 8 dS/m, S3=soil with EC of 12 dS/m. The bars represent the means standard deviations. The histograms assigned by the same letter are not statistically different according to the LSD test with a 5% threshold).

3.6 Changes in onion bulb yields

The yield of onion bulbs, between 896.4 and 7832.0 kg/ha, is significantly higher under the control soil than that under S1 and S2 for all varieties except under the Prema variety (V2) where the onion bulb yield is almost similar between soil salinity levels. Under local variety, bulb yield under control soil (7832.0 kg/ha) is respectively 3.2 and 8.7 times higher than that under S1 (2406.2 kg/ha) and S2 (896.4 kg/ha).

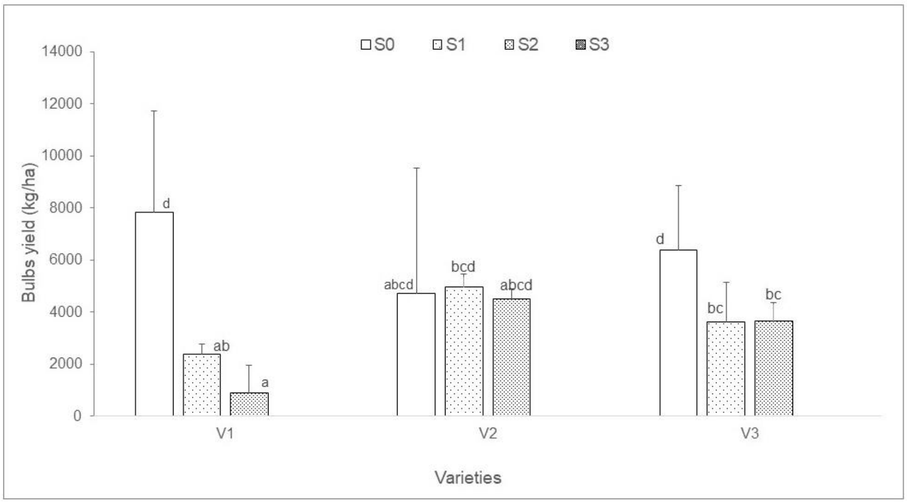

Figure 8. The Yield of onion bulbs under different soil salinity levels and varieties (V1=Local variety, V2= Prema variety, V3=Violet de Galmi variety, S0= control soil, S1= soil with EC of 3 dS/m, S2= soil with EC of 8 dS/m, S3=soil with EC of 12 dS/m. The bars represent the means standard deviations. The histograms assigned by the same letter are not statistically different according to the LSD test with a 5% threshold).

3.7 Relationship between soil salinity and onion agronomic parameters

Table 3 presents the correlation matrix between soil salinity and onion agronomic parameters. The results show a significant negative correlation between soil salinity (soil electrical conductivity) and biomass and bulb yields ($p<0.0001$). Furthermore, the height and the diameter of onion plants at 111 Days After Transplanting were positively and significantly correlated with the diameter of onion bulbs ($p<0.0001$).

Table 3. Person's correlation matrix (5%) between soil salinity and onion agronomic parameters

Variables	EC	Bulbs yield	Biomass yield	Bulb diameter	Plants height	Plants diameter
EC	**1**					
Bulbs yield	**-0,607**	**1**				
Biomass yield	**-0,561**	**0,586**	**1**			
Bulbs diameter	0,035	0,027	0,073	**1**		
Plants height	-0,079	0,074	0,308	**0,590**	**1**	
Plants dimater	-0,034	0,043	0,202	**0,729**	**0,837**	**1**

Notes. The values in bold are different from 0 to Alpha significance level =0.05. Data on plant diameter and plant height are collected at 111 Days After Transplanting.

4. Discussion

4.1 Influence of soil salinity on onion growth parameters

The results of this study showed that soil salinity leads to a reduction in the growth of onion plants. Indeed, the number of leaves, plant height, and plant diameter of onion crops decrease with increasing soil salinity levels under all varieties. Moreover, an early cessation of growth was observed on the soil with EC of 16 dS/m following plants wilting respectively at 60, 48, and 56 days after transplanting under local variety (V1), Prema variety (V2), and Galmi violet variety (V3).

The reduction in onion growth under the effect of salt stress has been reported by several authors [28-32]. [28] showed that soil salinity can reduce onion growth by 40-50%, particularly in plant height, and leaf number. Furthermore, [29] showed that increasing the salinity of irrigation water from 1.21 to 9.55 dS/m caused a reduction of 74 and 59% respectively in leaf number and leaf height of onion crop. The effect of salinity on growth has also been shown in several other vegetable crops such as tomato [33, 34], pepper [35], cabbage [36]; okra [21]. However, the Prema variety seems to be more tolerant to soil salinity than the two other varieties (V1 and V3) in plant height and diameter of stem plants. These results confirm the report of [21] which showed that salt tolerance can vary between species and between varieties. This reduction in the growth of onion plants by soil salinity can be explained by two main mechanisms including i) the increase in osmotic pressure which limits water and nutrients uptakes by onion plants and ii) the toxicity of salt solutes which disrupts metabolism and inhibit plant growth [37-40].

4.2 Influence of soil salinity on biomass and bulb yields of onion crops

This study also showed that soil salinity leads to reduced onion yields. Indeed, the yield of onion bulbs decreases significantly with an increase in soil electrical conductivity under all varieties. Compared to control soil salinity (0.68 dS/m), an increase in soil salinity levels (3-16 dS/m) caused a reduction in onion bulb yield of 43 to 88%, particularly under local (V1) and Galmi violet (V3) varieties. Under local variety, bulb yield under control soil (7832.0 kg/ha) is respectively 3.2 and 8.7 times higher than that under S1 (2406.2 kg/ha) and S2 (896.4 kg/ha). This same trend was observed with the biomass yield. These results were confirmed by the correlation test which showed a significant negative correlation between soil salinity (EC) levels and the yields of bulbs and onion biomass ($p<0.0001$). The results of this study are in agreement with those reported by several authors [29-31]. Indeed, [29] showed that increasing the salinity of irrigation water from 1.21 to 9.51 dS/m caused a reduction of 64 and 91% respectively in bulb diameter and bulb fresh weight. However, the Prema variety, where no significant difference was found between soil salinity levels in bulb yield, appears to be more tolerant to soil salinity than other varieties, particularly for bulb production. These results also were in agreement with [31] who also reported that salinity tolerance in onions varies between varieties. However, the bulb yield obtained in this study, between 896 and 8000 kg/ha, is lower than the potential yield indicated under all varieties studied which varies between 40 000 and 60 000 t/ha [27]. This difference would be explained by the test conditions (confined conditions in soil pots) which would limit the exploration of soil volume to normal plant growth and bulb formation. Furthermore, the negative effect of salinity on crop production has also been observed in other vegetable crops, notably peppers [4], green beans [41], tomatoes [42], and okra [21].

5. Conclusion

The present study showed that soil salinity has negative effects on plant growth and yields (bulbs and biomass) of three (03) onion varieties cultivated in the Tahoua region of Niger. Indeed, the results showed that leaf number, plant height, and diameter of onion plants decrease with increasing soil salinity levels in all varieties. Moreover, an early cessation of growth was observed on the soil at an EC of 16 dS/m. The yield of onion bulbs and biomass decreases significantly with the increase in the electrical conductivity of the soil, particularly in the local variety. Compared to control soil salinity (0.68 dS/m), an increase in soil salinity levels (3-16 dS/m) caused a reduction in onion bulb yield of 43 to 88%, particularly under local (V1) and Galmi violet (V3) varieties. However, the Prema variety appears to be more salt-tolerant variety than the local variety and Galmi violet variety, particularly in plant growth and bulb production. Thus, this study shows that soil salinity, which is increasingly developed in irrigated land in Niger, is a threat to onion production.

References

[1] Hamdoud, N. (2012). Effect of salt stress on growth and physiology of Faba bean (Vicia faba L.). Master's thesis, National Higher Agronomic School of El-Harrach, Alger. P. 59.

[2] Lobna Z., Gharbi F., Rezgui F., Salwa R., Hassan N., Mohamed N.R. (2007). Effects of salt stress on growth and photoprotection mechanisms of tomatoes, Annals of INRGREF N°11: 189-202.

[3] Amouri A. A. (2016). Molecular and biochemical characterization under salt stress conditions of Medicago truncatula Gaertner, PhD thesis, University of Oran, p. 173.

[4] Challita C. and Moujabber M.E. (2004). Effect of salinity on pepper crop yield (*Capsicum annum* L.). Annals of scientific research 5: 115-127.

[5] Dahli K. (2019). Combined action of herbicide and salinity on germination of Okra (*Abelmoschus esculentus* L.). PhD thesis, Oran University, p. 80.

[6] Kouadria M., Sehari M., Hassani A., Koulali F., Zouablia S. (2020). Effect of salt stress on leaf system of food legume (Phaseolus

vulgaris L.) grown in bentonite soil. Rev. Mar. Sci. Agron. Vet., 8 (1): 37-41.

[7] Foley, J.A., Ramankutty, N., Brauman, K.A., Cassidy, E.S., Gerbe James, S., Johnston, M., Mueller, N.D., O'Connell, C., Ray, D.K., West, P.C., Balzer, C., Bennett, E.M., Carpenter, S.R., Hill J., Monfreda, C., Polasky, S., Rockstro, J., Sheehan, J., Siebert, S., Tilman, D., Zaks, D.P. M. (2011). Solutions for a cultivated planet. Nature, 478: 337-342.

[8] Kadu, P.R., Vaidaya, P.H., Balpande, S.S., Satyavathi, P.L.A., Pal, D.K. (2003). Use of hydraulic conductivity to evaluate the suitability of vertisols for deep-rooted crops in semiaride parts of central India. Soil Use and Management, 19: 208-216.

[9] Marlet S., Job, J.O. (2006). Soil salinity processes and management. In: Tiercelin J.R, Vidal A., Tardieu H., Irrigation treaty. Edition. Tec & Doc Lavoisier, 797-822.

[10] Olivier G. (2015). Saline dynamics of soils in arid and semi-arid environments. HDR Thesis, University of Montpellier. P. 131.

[11] Diallo M.D., Diaite B., Diedhiou I., Diedhiou P.M. (2016). Study of the sensitivity of three accessions of Jatropha curcas L. under salt stress conditions rev. CAMES-VOL., 04 (02): 78-83.

[12] Marlet S., Vincent B., Vidal A., Bouarfa S., Wu J., Yang J., N'Diaye M.K., Kuper M., Zimmer D. (2005). Water and salinity management and salt redistribution in irrigated areas, international commission on irrigation and drainage. Symposium R.12, 18p.

[13] Mazinga K.M., Banza M.J., Kabongo J. (2015). Effects of increasing doses of NaCl on the behavior of the banana plant and the morpho diversity of soil fungi. International Journal of Innovation and Applied Studies, ISSN 2028-9324 Vol. 10 (4):1150-1155p.

[14] Houria R. (2007). Relationship between water tables and salinity in gypsum soils of the Ain Ben Noui region. Biskra. Master's Thesis, El Hadj Lakhdar Batna University (Algeria), p. 82.

[15] Guéro Y. (2000). Study of mechanisms of physicochemical degradation of soils in Sahelian climate. PhD thesis. Abdou Moumouni University of Niamey, Niger, p. 109.

[16] Adam I. (2011). Fine mapping and detailed monitoring of soil salinity in irrigated area in Niger to their remediation. PhD thesis. Abdou Moumouni University of Niamey (Niger) and Agrocampus Ouest of Rennes, (France), p. 219.

[17] Ado M. (2017). In situ evaluation and under controlled conditions of phytodesalination of irrigated Vertisols. Case study of irrigated paddy system in the Niger River valley. PhD thesis. Abdou Moumouni University of Niamey (Niger) and Agrocampus Ouest of Rennes, (France). P. 235.

[18] Michot, D., Walter, C., Adam, I., Guéro, Y. (2013). Digital assessment of soil-salinity dynamics after a major flood in the Niger River valley. Geoderma, 207-208: 193-204.

[19] Montoroi J.P. (1993). Management of agro-sylvo-pastoral systems in tropical areas. University of Paris. P. 54.

[20] Alexis N. L., Mouaragadja I., Brahma. I, Séverin. A et M'batchi B. (2012). Response of corn (*Zea mays var*. LG 60) to salt stress: study of the synthesis of some biochemical compounds. Journal of Animal & Plant Sciences, 1866-1872.

[21] Gouveitcha M. B, Mensah A.C. G., Montcho H.K.D., Assogba K.F., Gandonou C. B. (2021). Response to salt stress of some okra cultivars (*Abelmoschus esculentus* (L.) Moench) produced in Benin at the young plant stage. Journal of Applied Biosciences, 161: 16616-16631.

[22] R'him T., Tlili I., Hnan I., Ilahy R., Benali A., Jebari H. (2013). Effect of salt stress on the physiological and metabolic behavior of three varieties of pepper (C*apsicum annuum* L.). Journal of Applied Biosciences, 66: 5060-5069.

[23] Alaoui M. M., El Jourmi L., Ouarzane A., Lazar S., El Antri S., Zahouily M., et Hmyene A. (2013). Effect of salt stress on germination and growth of six Moroccan wheat varieties, J. Mater. Environ. Sci., 4 (6): 997-1004.

[24] Boukary H., Roumba A., Adam T., Barrage M., Saadou M. (2012). Interactions between the variability of onion (Allium cepa L.) ecotypes and agro-climatic factors in Niger. Tropicultura, 30 (4): 209-215.

[25] MAG/EL. (2021). Statistical files in irrigated crops between 2011 and 2020. Ministry of Agriculture and Livestock (MAG/EL), Direction of Agricultural Statistics (DSA).

[26] Abdou R. (2014). Characterization in genetic diversity of onion cultivars (*Allium cepa* L.) in Niger, PhD thesis. University de Liège -Gembloux, p. 151.

[27] MA/CNS. (2021). National Catalog of Plant Species and Varieties (CNEV). Report, Ministry of Agriculture, Niger, p. 307.

[28] Yadav, S. S., Singh, N., Yadav, B. R. (1998). Effect of different levels of soil salinity on growth and yield of onion (Allium cepa). Indian Journal of Horticulture, 55(3): 243-247.

[29] Sta-Baba, R., Hachicha, M., Mansour, M., Nahdi, H., Kheder, M. B. (2010). Response of onion to salinity. African Journal of Plant Science and Biotechnology, 4(2): 7-12.

[30] Hanci, F., & Cebeci, E. (2015). Comparison of salinity and drought stress effects on some morphological and physiological parameters in onion (Allium cepa L.) during early growth phase. Bul J Agri Sci, 21(6): 1204-1210.

[31] Chaudhry, U. K., Gökçe, Z. N., Gökçe, A. F. (2020). Effects of salinity and drought stresses on the physio-morphological attributes of onion cultivars at bulbification stage. Int J Agric Biol, 24 (6): 168-189.

[32] Khalaf M. Khalefah, Ghassan J. Zaidan and Mohammed J. Farhan. (2022). Effect of potassium fertilizer and salt stress on growth and yield of onion (*Allium cepa* L.) cultivated in gypsiferous soil. International Journal of Agricultural and Statistical, 18(1): 113-118.

[33] Regragui A., Rahouti M., Lahlou. H. (2013). Effect of salt stress on Verticillium albo-atrum: pathogenicity and production of cellulolytic enzymes in vitro. Cryptogamie, Mycologie, 24 (2): 167-174.

[34] Zribi L., Gharbi F., Rezgui F., Rejeb S., Hassan N., Mohamed N.R. (2008). Effects of salt stress on growth and photoprotection mechanisms in tomato plant. Annals of INRGREF, N°11: 189-202.

[35] Kpinkoun J.K., Zanklan S.A., Françoise A.K., Armel C.G., David M., Kinsou E., Christophe B.G. (2019). Evaluation of resistance to salinity at the young plant stage of some pepper cultivars (*Capsicum spp*.) in Benin. Journal of Applied Biosciences, 13561-13573.

[36] Gouveitcha M.B., Koffi D.M., Séraphin A. Z., Agapit D.W., Gandonou G.B. (2020). Evaluation in resistance to salinity of three varieties of cabbage (Brassica oleracea) in Benin at germination stage. Journal of Applied Biosciences, 147: 15140-15150.

[37] Winicov, I. (1998). New molecular approaches to improving salt tolerance in crop plants. Annals of Botany, 82: 703-710.

[38] Sultana N., Ikeda T., Itoh R. (1999). Effect of NaCl salinity on photosynthesis and dry matter accumulation in developing rice grains. Environmental and Experimental Botany, 42: 211-220.

[39] Munns R., Tester M. (2008). Mechanisms of salinity tolerance. Annual Reviews of Plant Biology, 59: 651-681.

[40] Hanana M., Hamrouni L., Cagnac O., Blumwald E. (2011). Mechanisms and cellular strategies of plant salinity (NaCl) tolerance in plants. Environmental Files, 19: 121-141.

[41] Naimi Fet Merdj A. (2018). Effect of salt stress on the germination and development of bean plants (*Phaseolus vulgaris* L). Master's Thesis, Djilali Bounaama University of Khemis Miliana (Algeria), p. 56.

[42] Guedda K et Djaber O. (2016). Evaluation in behavior of three varieties of tomato (*Lycopersicum esculentum* L) under salt stress. Master’s thesis, Echahid Hamma Lakhdar University of El-Oued (Algeria), Faculty of Natural and Life Sciences, p. 66.