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Organic and inorganic nutrient sources influeced growth, flowering, fruition, fruit relative water content and yield of pepper (*Capsicum annuum* L.) cultivars under salinity in coastal region of Cameroon

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Abstract

Fruit relative water content, carotenoid total chlorophyll content, flowering, fruition, growth and yield parameters of pepper (*Capsicum annuum* L.) cultivars: 'Granada', 'Goliath' and 'Nobili' were evaluated under two level of irrigation water: tap water (control) and tap water + 50mm NaCl, organic and inorganic fertilization in order to determine the field performance, for the improvement of smallholder agriculture in Cameroon. Four fertilizer application rates (0, 3, 6 and 12 $t.ha^{-1}$) of Water Lettuce (WL) and Poultry Manure (PM) and 100kg/ha of NPK were used in a randomized complete block design experiment with four replications. The results overall indicated that the raising of fertilizer application rate of PM an WL increased significatively ($p<0.05$) carotenoid content, fruit water content, growth and agronomical parameters and decreased the date of flowering and fruition for all varieties studied compared to the control and NPK fertilizer, and what it regardless of the level of salinity. Application of WL or PM at 12 t ha^{-1} and NPK significantly increased fruit water content, growth and yield parameters in Granada compared to other cultivars. Irrigation of saline water decreased significantly ($p<0.05$) growth and yield parameters of all varieties. Significant ($p<0.05$) increased in growth parameters was observed in all cultivars at NPK fertilization. 'Granada' showed better growth and yield than 'Nobili' and 'Goliath' revealing a greater response of this cultivar to fertilization. This study is important contribution to identify tolerant cultivars for salt stress and permit to restore soil fertility and increase yield in coastal areas in Cameroun througth culture of Granada tolerant's cultivar for salt stress.

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Introduction

Pepper (*Capsicum annuum* L.) is a spice, a fruit vegetable widely grown in the world as it is very important human food (Wahyuni *et al.*, 2013). It is one of the three important solanaceous vegetable crops grown for their fruits which are consumed either fresh or dried (Wahyuni *et al.*, 2013). Pepper belong to the crops grown throughout the world for their nutraceutical (nutritional and medicinal) and economic virtue (Rahman *et al.*, 2013). In almost every tropical country, pepper has become the most popular condiment used to add zest and flavor to otherwise dull foods (Alabi, 2006). It has extensive culinary uses. It is used in pickles, ketchup and sauce seasoning dishes and in sausages (Purseglove, 1968). Pepper is rich in vitamins especially ascorbic acid and vitamin A. Bosland and Votava (2000) reported that pepper contains more vitamin C than tomato. Uzo (1982) reported that pepper is the major source of capsaicin, an alkaloid, which is used in medicine as a digestive stimulant. Thus consumption of peppers may prevent various diseases associated with free radical oxidation, such as cardiovascular disease, cancer and neurological disorders (Howard *et al.*, 2000). Peppers also contain various phenolics, flavonoids and carotenoids (Materska and Perucka, 2005). In Cameroon, pepper is grown only for food in west, south, littoral and center region partially in the cultivate land of the coastal and semi arid areas where soil salinity and water irrigation constitute a reality.

Farmers are always faced with the problem of soil fertility decline which has been considered as the most important biophysical constraints to crop yield and productivity (Odendo *et al.*, 2004). Integration of organic fertilizers such as green manure and poultry manure into the farming systems can be a cheaper alternative to alleviating low soil fertility and erosion problems (Odendo *et al.*, 2004). Numerous study have shown the positive influence of green manure on growth and yield of maize (Ayuke *et al.*, 2004; Nziguheba *et al.*, 2004) and wheat (Marschner andmcNeill, 2011). This can, in part, be due to nutrients released by the decomposing green manure (Leconte *et al.*, 2011). Large scale investigations over many years on the cultivation of water lettuce on various effuents have shown that they give an increase in leaves and stems biomass of up to 1kg m^{-2} and more per day, which amounts to which amounts to 1800-2700 ton of raw material or 90-135 t (Shoyakubov and Aitmetova, 1999). Investigation to use the plant as green manure to enhance growth and yield of crops are not well documented (Edema *et al.*, 2007). Poultry manure is a nutrient source for crop production (Schomberg *et al.*, 2011). Poultry manure amendment has been shown to increase soil organic C, total N and available P (Lv *et al.*, 2011).

Incorporation of poultry manure into soil promoted transformation and mineralization of less-labile inorganic and organic P into labile-P, in the rhizosphere, which result in higher root P concentrations and higher total P uptake by plants (Waldrip *et al.*, 2011). The poultry manure could be a valuable fertilizer and could serve as a suitable alternative to chemical fertilizer in the coastal region of Cameroon. However, there seems to be little use of green and poultry manure in Cameroon and there is little knowledge available on their effects on crops for efficient utilization. Developing soil fertility management options for increasing productivity of stable food crops is a challenge in most parts of sub-Saharan Africa, where soils are constrained by nitrogen and phosphorus deficiencies (Jemo *et al.*, 2010). Nitrogen, phosphorus and potassium are among the limiting nutrients for cereals and food legumes production (Christianson and Vlek, 1991; Manu *et al.*, 1991). Adequate supply of nitrogen is beneficial for carbohydrates and protein metabolism, promoting cell division and cell enlargement (Shelu *et al.*, 2010). Similary, good supply of P is usually associated with increased root density and proliferation which aid in extensive exploration and supply of nutrients and water to the growing plant parts, resulting in increased growth and yield traits (Maiti and Jana, 1985). Due to the vital role that potassium plays in plant growth and metabolism, potassium-deficient plants show a very general phenotype, which is characterized by reduced growth, photosynthesis and impaired osmoregulation and transpiration (Amtmann *et al.*, 2006).

But, problems such as soil salinity, lack of fertile soil, and soil-borne diseases are causes of hindrance for pepper production in soil. Therefore, to overcome these problems, soilless culture was developed (Savvas and Gruda, 2018). Excessive salinity is the most important environmental stress factor that greatly affects the growth, nutrition and productivity of many plant species (Deinlein *et al.,* 2014).

The response of plants to excess salinity is complex and involves morphological and developmental changes as well as physiological and biochemical processes. Salinity induces changes in physiology and metabolism that affect the final crop yield (Pompeiano *et al*., 2016). Morphologically the most typical symptom of saline injury to plants is the reduction of growth (Jaleel *et al*., 2008), which is a consequence of several physiological responses including modification of ion balance, water status, mineral nutrition, photosynthetic efficiency, carbon allocation and utilisation, membrane instability, and failure in the maintenance of turgor pressure (Yildirim *et al*., 2009).

It was reported that salt stress decreases the final percentage of yield, longer and diameter of fruit (Navarro *et al*., 2010; Maaouia-Houimli *et al*., 2011), growth and productivity (Ly *et al*., 2014) in pepper. Pepper is classified as moderately sensitive to salinity (Chookhampaeng, 2011) and some adverse effects of salinity on this species have been reported (Huez-Lôpez *et al*., 2011). Indeed, the present study aims to evaluate effects of NaCl stress, organic and inorganic nutrient sources on the flowering, fruition, relative water content and yield in pepper (*Capsicum annuum* L.) cultivars in coastal region of Cameroon. Precisely, this research aimed to assess the ability of beneficial organic and inorganic fertilizers application to valorize pepper crop nutrition and production by encouraging the plants to tolerate as high soil NaCl as possible, thus improving fruit production and quality. In this respect, the interaction between organic and inorganic fertilizers and different soil NaCl induced by fertigation with balanced nutrient solutions was assessed on growth, yield and quality of pepper fruits grown in coastal region of Cameroon.

Materials and methods

Site description

The field experiments were conducted during the 2017 and 2018 cropping seasons at University of Douala research farm (4°01N, 9°44 E, 13 m.a.s.l.), in the coastal region of Cameroon. The climate belongs to the equatorial domain of a particular type call Cameroonian characteristics by two seasons with a lengthy rainy season (at least 9 months), abundant rainfalls (about 3597mm per year), high and stable temperatures (26.7°C). The relative humidity remains high the whole year and near to 100%. The soil of the experimental site is classified as yellow ferralitic soil.

Field experiment

Three pepper cultivars (*Capsicum annuum* L.) were used in this experiment: 'Granada', 'Goliath' and 'Nobili'. Seeds were provided by the breeding program of the Agronomic Institute for Research and Development (IRAD, Nkolbissong). The experiwas in a randomized complete block design with four replicates. The plots measuring 4×4m, comprised of four fertilization rates (0, 3, 6 and 12 t h^{-1}) each of Water Lettuce (WL) and Poultry Manure (PM) and 100kg ha^{-1} of NPK.

The field was ridged 0.9m apart with intra-row spacing of 0.50m, three seeds were sown per hill and the seedling thinned to one plant per hill 1 Week after Showing (WAS) to give a population of 22000 plant ha^{-1}. The amendment in each case was applied 6 WAS. The water lettuce was collected from lakes around Douala while the poultry manure was provided by commercial chicken production. Selected water lettuce and poultry manure chemical properties are shown in Table 2.

Nitrogen was applied as urea (100kg ha^{-1}), while phosphorus and potassium were applied as single superphosphate (150kg ha^{-1}) and chloride of potash or sulphate of potash (120kg ha^{-1}), respectively. PACHA 25 EC (systematic insecticide) at 500 g of active matter per hectare and METROSTAR 500 WP (polivalent fungicide) at 400 g of active matter per hectare was applied as pre-emergence weed control measure and supplementary hoe-weeding was done at

4 and 8 WAS. Treatments consisted in plant irrigation every two days with 100mL/pot of two level of saline water. Each cultivar was subjected to tap water (control) and tap water + 50mm NaCl solution corresponding respectively to an electric conductivity of 1.34 and 3.88 dS.m^{-1} determined by a conductometer (VWR; CO310) for 3 month.

Soil, water irrigated, water lettue, poultry manure sampling and analysis

Soil samples were collected from representative spots on the experimental site from where soil was collected for potting using soil auger to a depth of 20cm, the samples were made into a sample. A sub-sample was taken, air-dried, crushed and sieved with 2-mm mesh sieve after which physical and chemical analyses were carried out (Table 1). Water lettuce samples which were collected from lakes around Douala were washed with distilled water, pressed under blotting papper and their fresh weight recorded. Afterwards, the plant samples were air-dried, ground and sieved through a 2mm sieve. Irrigation water were collected from local tap. Poultry manure was stored in an airtight container at 22°C for approximately 1 year before use. The following chemical analyses were done on the soil, water lettuce, water irrigated and poultry manure (Tables 1, 2 and 3). Organic carbon (C), was determined by the wet oxidation procedure (Walkley and Black, 1934) and total Nitrogen (N) by micro-Kjeldahl digestion method. Magnesium (Mg) was extracted using the Mehlich 3 method and determined by auto ANALYSER 5Technicon 2). The total and available soil phosphorus (P) were determined by the method of Okalebo and al. (1993). Soil was measured potentionmetrically in 1:2.5 soil: water mixture. Calcium (Ca), potassium (K) and sodium (Na) were determined by aflame photometer (JENWAY) as described by Taffouo and al. (2008). Ca^{2+},mg^{2+}, Na^{+}, K^{+}, HCO_3^{-}, SO_4^{2-}, NO_3^{-}, Cl^{-} content in water tap was determined by using colorimetric amperometric titration method (Taleisnik *et al.*, 1997) (Table 3). Electric conductivity and pH were determined by conductometer.

Table 1. Physical and chemical characteristics of soil used.

Physio-chemical Properties	Quantity
Clay%	14,20 ± 1,20
Coarse sand%	27,90 ± 2,10
Fine sand%	25,60 ± 1,80
Coarse silt%	26,00 ± 1,60
Fine silt%	6.30 ± 0,50
Total carbon%	0,75 ± 0,05
Total nitrogen%	0,32 ± 0,01
Ratio C/N%	2,34 ± 0,02
Moisture (%)	0,99 ± 0,14
Phosphorus (ppm)	4,60 ± 0,10
Potassium (gkg^{-1})	0,25 ± 0,02
Sodium (gkg^{-1})	2,7 ± 0,01
Calcium (gkg^{-1})	0,23 ± 0,01
Magnésium (gkg^{-1})	0,17 ± 0,01
pH	8,47 ± 0,10
EC	2,24 dS/m

Table 2. Nutrient contents of water lettuce and poultry manure.

	Nutrient concentration (gkg^{-1})						
Nutrient source	N	C	P	Na	K	Ca	Mg
Water lettuce	11.88	24	86.12	11.25	24.01	103.78	19.93
Poultry manure	22.18	28	8.97	3.96	13.86	14.89	6.69

Table 3. Chemical characteristics of irrigation water.

	Chemical characteristics								
Irrigation Water	Ca^{2+} (mg g^{-1})	Mg^{2+} (mg g^{-1})	K^{+} (mg g^{-1})	HCO_3^{-} (mg g^{-1})	Na^{+} (mg g^{-1})	SO_4^{2-} (mg g^{-1})	Cl^{-} (mg g^{-1})	Ph	CE (dS m-1)
Tap water	233.2	116.8	23.4	61.7	438.1	518.8	26.1	7.31	1.34
Tap water + 50mm NaCl	229	401.2	20.9	63.7	923.4	601.6	58.9	7.83	3.88

Plant growth parameters

Plants were harvested 120 DAP, plant height (cm), number of leaves/plant and total leaf area (cm^2/plant) were measured. Fruits were separately dried at 70°C for 72h, and their fruit dry weights (g) were determined. The RWC of fruit {(fruit FW - fruit DW) × 100/fruit FW} and TLA (length × width × 0.80 × total number of leaves × 0.662) were calculated using the methodology described by Kumar *et al.* (2002). Fresh leaves and fruits (90 and 120 days after transplanting, respectively) were extracted with acetone (80%) (Sigma-Aldrich Co. LLC) and placed for one hour at 5ºC. The extractions were centrifuged for 15 min at 3,000 x *g*. Chlorophyll *a*, *b*, and carotenoids content were measured with a spectrophotometer (Helios UVG1702E, England) at wave lengths 663, 647, and 470 nm, respectively. Chlorophyll and carotenoids were measured according to the method of Lichtenthaler and Wellburn (1983). The calculation was done according to the following equations:

Chlorophyll a = 12.70 × A663 - 2.79 × A647

Chlorophyll b = 20 × A647 - 4.62 × A663

Carotenoids = {1000 × A470 – (3.27 chl. A – 104 chl. B)}/229

Flowering and fruition evaluation

The date of appearance of the first flowers and the first ripe fruits (having reached the physiological maturity determined by the first signs of color change) was noted for each treatment. Thus, the number of days set by each plant to give its first flower and first ripe fruits from the start of the manure and stress application were raised.

Irrigation water

Two irrigation water salinities: local tap water and the highest salinity level (EC of 3.88 $dS{\cdot}m^{-1}$) was achieved by an equivalent addition of sodium chloride salts to the local tap water were applied for each water quality (Table 3).

Yield and its components

After 120 DAS, number of fruit per plant, fresh fruit weight, dry fruit weight, thickness of fruit, number of seeds per fruit, 1000 grain weight, fruit yield, seed yield were determined for each cultivar and treatment. The fruit length and diameter were measured as described by Adedeji *et al.* (2006).

Statistical analysis

The experiment was conducted as a factorial completely randomized design with four NaCl treatments and three cultivars in five replications. Data are presented in term of mean (± standard deviation). All data were statistically analysed using Statistica (version 9, Tulsa, OK, USA) and first subjected to analyses of variance (ANOVA). Statistical differences between treatment means were established using the Fisher LSD test at $p < 0.05$.

Result and discussion

Effects of organic and inorganic fertilizers application and salinity on fruit water content, flowering and fruition

Fruit water content significantly ($p<0.05$) increased in all pepper cultivars with increasing Water Lettuce (WL), Poultry Manure (PM) fertilization rates (Fig. 3). The highest value of 91.3% RWC was observed in Goliath at the highest application of rate (12 t ha^{-1}) of WL (Fig. 1). Morever, the application of PM at 12 t ha^{-1} increased the fruit water content from 79.88% to 90.4% RWC in Granada (Fig. 3). While, flowering and fruition rate significantly ($p<0.01$) decreased with increasing WL and PM fertilization rates in all pepper cultivars (Fig. 1 and 2). The best decrease value of flowering of 60.7 and 57.9 days was observed in Granada at the highest application of rate (12 t ha^{-1}) of WL and PM respectively. When, the application of WL and PM at the 12 t ha^{-1} decreased the fruition from 123.4 to 110.3 days and 105.7 days respectively in Granada (Fig. 2). Application of NPK fertilizers rate significantly ($p<0.05$) increased the fruit relative water content, flowering and fruition rate of all cultivars (Fig. 1, 2 and 3).

The highest value of the fruit relative water content, flowering and fruition rate were observed in Granada compared to control (Fig. 1). Similar results were found in *Salix sericea* (Lower and Orians, 2003). According to Hossner and Juo (1999), the beneficial effect of organic nutrient is to improve soil structure and increase water holding capacity. Physiologicaly, the uptake of nutrients depends on water availability (Marschner, 1986). Flowering and fruition rate were significantly ($p<0.05$) increased in all pepper cultivars with increasing WL and PM fertilization rates. These results shown that WL and PM fertilization favoured fruit matter weight and soluble sugar accumulation in fruit (Boateng *et al.*, 2006; Sharifa and Abu-Muriefah, 2015). NaCl effect on fruit water content, the date of appearance of the first flowers and the first fruit is shown in Fig.s 1, 2 and 3. Salinity at 50mm NaCl decreased significantly ($p<0.01$) the fruit water content from 79.8% - 75.7%;

84.5% - 79.4%; 89.8% - 84.3% and 90.4 – 86.6% at control, NPK, (12 t ha^{-1}) of WL and PM respectively in Granada. The date of appearance of the first flowers and the first fruit were negatively influenced by salinity. Flowering rate varied from 72.8 – 76.2; 69.5 – 71.6; 60.7 – 66.2; 57.9 – 62.6 days respectively at control, NPK, (12 t ha^{-1}) of WL and PM and fruition rate varied from 123.4 – 129.3; 119.2 – 124.6; 110.3 – 115.4 and 105.7 – 112.4 days respectively at control, NPK, (12 t ha^{-1}) of WL and PM in Granada (Fig. 1 and 2). These results may be attributed to Munns (2002) studies, salinity reduces the ability of plants to take up water, and this quickly causes reductions in growth rate, along a suite of metabolic changes identical to those causes by water stress. Salt stress leads to suppression of plant growth and development at all growth stages, however, depending upon plant species, certain stages such as germination, seedling or flowering stage could be the most critical stages for salts stress (Khoshsokan and *et al.,* 2012. In *Iris hexagona*, Van Zandt and Mopper (2002) reported that salinity strongly delayed flowering phenology mainly in the second year when less than 4g/L NaCl delayed flowering up to 3 days. According to Shrivastava and Kumar (2015), salinity adversely affects reproductive development by inhabiting microsporogenesis and stamen filament elongation, enhancing programed cell death in some tissue types, ovule abortion and senescence of fertilized embryos. These effects were the results of a low osmotic potential of soil solution (osmotic stress), specific ion effects (salt stress), nutritional imbalances, or a combination of these factors (Ashraf, 2004).

Effects of NaCl, water lettuce and poultry manure application growth and yield parameters

Application of WL affected growth parameters of pepper (Table 4). 12 t ha^{-1} of WL significantly ($p<0.01$) increased the total leaf area and number of leaf in Granada at 356.3 to 375.6cm² and 36.6 to 54.5 respectively (Table 4). The highest increase in plant height (from 49.8 - 60.9cm) was recorded in Nobili under WL treatment at 12 t ha^{-1} (Table 4). The application of PM positively influenced the growth parameters studied in all cultivars with increasing fertilization rates (Table 4). Plant height, leaf area and number of leaf were considerably increased from 48.2 to 61.6cm; 356.3 – 380.9cm² and 36.6 – 64.5 respectively in Granada cultivar, when PM was applied at 12 t ha^{-1} and the highest value of plant height (64.5cm) was observed in Nobili (Table 4). The yield parameters of pepper were positively influenced by application of WL and PM at 12 t ha^{-1} in all cultivars (Table 5). The highest value of the fruit fresh weight, fruit length, number of seed per fruit, fruit yield, grain yield and the 1000 grain weigh were observed in Granada compared to control. On the other hand, there was significant increase in the thinckness of fruit from 5.3 – 6.5mm in Nobili while the highest increase values of fruit diameter, number of fruit per plant and fruit yield (7.3 – 9.2cm; 10.6 – 15.8; 10.3 – 12 t ha^{-1}, respectively) were recorded in Goliath at 12 t ha^{-1} under WL application (Table 6). Similar outcomes were obtained earlier on several landraces (Marschner andmcNeill, 2011).

It is well established that WL has a higher NPK concentration and undergoes rapid mineralization (Edema *et al.*, 2007; Rahman *et al.,* 2011). According to Hossner and Juo (1999), the organic matter increases the capacity of the soil to buffer changes in pH, enhances the Cation Exchange Capacity (CEC), reduces phosphate fixation and serves as a reservoir for secondary nutrients and micronutrients. Ayuke *et al.* (2004) reported that, the variation observed among landraces was due to the fact that in the organic residues treatments, nutrient availability depended on nutrient concentration and release in synchrony with crop needs. The highest plant growth and yield obtained in the PM and WL fertilizer at 12 t ha^{-1} could be attribuated to the nutrients being readily available from the PM and WL fertilizer. This is in agreement with the results obtained by Perkins (1964), Boateng *et al.* (2006) and Lv *et al.* (2011). According to Waldrip *et al.* (2011), the incorporation of poultry manure into soil promoted transformation and mineralization of less-labile inorganic and organic P into labile-P, in the rhizosphere, which result in higher root P concentrations and higher total P uptake by plant. The significant decreased ($p<0.05$) of NaCl on growth and yield parameters is shown in Tables 4, 5 and 6.

The saline water irrigation in soil without or with application of organic fertilizers decreased the growth and yield parameters of all pepper cultivars at different growth period. Interaction effect between salinity stress, organic and inorganic fertilizers application levels showed significant differences for growth and yield parameters of pepper (Table 4, 5 and 6). Salt stress is known to retard plant growth through its influence on several vital factors of plant metabolism, including osmotic adjustment nutrient uptake, protein and nucleic acid synthesis, photosynthesis (Zaibunnisa *et al.*, 2002), organic solute accumulation, enzyme activity, hormonal balance and reduced water availability at the cell level all of which result in reduced plant growth and ultimately reduced yield. Plant growth is compromised by salinity at all developmental stages, but sensitivity varies greatly at different stages (Gandonou and Skali, 2015).

The reduction of growth parameters in salt sensitive 'Goliath' is a consequence of several physiological responses including modification of ion balance, mineral nutrition, stomatal behaviour and photosynthetic efficiency (Mudgal *et al.*, 2010). Under salt stress 'Granada' was observed to have relatively higher tolerance on average of all growth parameters than 'Nobili', intermediate ones. Similar observations for plant growth were reported in 'White seed coat' (Taffouo *et al.*, 2010) and 'Fleur 11' (Meguekam *et al.*, 2014), described as salt-tolerant cultivars. Salt stress in this study, decreased yield parameters in pepper cultivar. Similar results were reported in pepper cultivar Sandia by Huez-Lopez *et al.* (2011) who observed that the mean fresh fruit yields decreased as soil salinity increased. In three other chili pepper cultivars, R'him *et al.* (2013) reported that salinity reduced the percentage of fruit set, yield and average fruit weight corroborating our results. However, Huez-López *et al.* (2011) found that, in chili pepper cultivar Sandia, fruit number was more affected by salinity than the individual fruit weight. In tomato, Parvin *et al.* (2015) reported that the fruit weight is gradually decreased with the increased levels of salinity. The decreasing of number of fruit and seeds consequencely carried away drop of fruit yield and grain yield of all pepper cultivars (Nabloussi *et al.*, 2008; Sharifa and Abu-Muriefah, 2015). In vegetable crops, it is well known that salt stress decreases marketable yield due to decreased productivity and an increased unmarketable yield of fruits, roots, tubers and leaves without commercial value (Machado and Serralheiro, 2017). It is the case in sweet pepper cultivar *Somontano* if we referred to Rubio *et al.* (2009). According to R'him *et al.* (2013), the marketable fruit reduction by salt treatment was mainly due to the increase in the number of fruit affected by blossom-end rot. Reductions in fruit yield are largely attributable to decreases in the viability of pollen or the receptivity of the stigmatic surface (Sakr *et al.*, 2004) and substantially increased abscission of flowers or young fruit due to ethylene induction by salinity. Other factors affecting cell division and cell expansion, such as tissue water status and the concentration of certain plant hormones e.g. ABA are also involved in the regulation fruit set under stress.

It was obvious that increasing salinity decreased economic of fruit yield due to the decreased number of perfect flowers and fruit set and imperfect fruit production and this has been reported elsewhere (Grattan *et al.*, 2002). Furthermore a reduction in leaf area reported in this study (Table 1) might result in reduction in the supply of carbon assimilate due to a decrease in the net photosynthetic rate and biomass accumulation (Sakr *et al.*, 2007). Hajiboland *et al.* (2010) had proposed that tomato (*Solanum lycopersicum L.*) growth and yield reduction affected by salinity could be the reasons for variation in photosynthetic products translocation toward root, decrease of plant top especially leaves, partial or total enclosed of stomata, direct effect of salt on photosynthesis system and ion balance.

Effect of NPK fertilization and NaCl on growth and yield parameters

Growth and yield parameters were positively influenced by NPK application in all pepper cultivars (Tables 4, 5 and 6). NPK application significantly ($p<0.05$) improved the number of leaf and total leaf area from 36.6 – 41.4; 356.3 – 360.3cm^2 respectively in Granada. However, the highest value of plant height (53.3cm) was recorded in Nobili (Table 4). Application of NPK significantly increased, the fruit fresh weight, fruit length, the 1000 grain weight, number of seeds per fruit and grain yield in Granada (Tables 5 and 6). While Goliath was observed to have higher value of fruit diameter, number of fruit and fruit yield from 7.7cm; 14.2 and 10.7 t ha^{-1} relatively (Table 5 and 6). Similar observations were reported by other researchers on various species but the reported optimum rates at which growth and yield were maximized varied widely (Bala *et al*., 2011).

This could be attributed to differences in nutrient inputs by the fertilizers and differences in nutrient demand by the crops (Hossner and Juo, 1999). According to Christianson and Vlek (1991), N, P and K are key elements in the production of leafy vegetables as they enhance yield by promoting cell division and expansion in leaves and root development. Studies carried out by Manu *et al*. (1991) revealed that nitrogen is among the limiting nutrients for cereals and food legumes production. Adequate supply of nitrogen is beneficial for carbohydrate and protein metabolism that promotes cell division and enlargement resulting in higher yield (Shehu *et al*., 2010). Similar, supply of P is usually associated with increased root density and proliferation, which aid in extensive exploration and supply of nutriments and wter to the growing plant, resulting in increased growth and yield traits, thereby ensuring more seed and matter yield (Maiti and Jana, 1985). The supply of K gave substantial increase in plant growth and yield of pepper cultivars. According to Amtmann *et al.* (2006), K is the most abundant inorganic cation in plants, comprising up to 10% of plant dry weight and is vital for various functions in the plant as photosynthesis, osmoregulation and transpiration.

NaCl effect on growth and yield parameters is shown in Tables 4, 5 and 6. A significant decrease ($p<0.01$) was observed for growth and yield parameters. The saline water irrigation in soil without or with application of NPK fertilizers decreased the growth and yield parameters of all pepper cultivars at different growth period. Fruit yield varied from 10.2 – 7.6 and 11.6 – 8.5 t ha^{-1} respectively at control and NPK; grain yield varied from 347.2 – 339.9 and 3352.2 – 344.5g ha^{-1} respectively at control and NPK in Granada (Tables 4, 5 and 6). The reductions of fruit numbers per plant, number of seeds, grain yield, 1000 grain weight, fruit fresh weight, grain yield and total fruit yield (t ha^{-1})under salt conditions are possibly due to the adverse impacts of salinity on the growth characteristics and physiological processes such as water uptake, photosynthesis, flowering, and fruit formation, which led to diminished yields. Similar results were also reported for tomato (Rahman *et al*., 2006; Saeed and Ahmad, 2009) and strawberry (Khayyat *et al*., 2007) grown in saline soil. The same trends of salt stress were previously described in faba bean (Abdul Qados, 2011) and strawberry plants (Yildirim *et al*., 2009).

Total chlorophyll and carotenoid content as affected by salinity, organic and inorganic fertilizers application

Total chlorophyll and carotenoid content were significantly ($p<0.01$) increased in all pepper cultivars with increasing WL and PM fertilization rates 16 WAS (Table 3). Application of WL and PM at 12 t ha^{-1} enhanced the chlorophyll content in Granada from 11.7 - 24.4 and 11.7 – 27.4 (mg g^{-1}) fresh weight respectively and carotenoid content varied from 0.35 – 0.68 and 0.35 - 072 (mg g^{-1}) fresh weight respectively.Application of NPK fertilizers rate significantly ($p<0.05$) increased the total chlorophyll and carotenoid content of all cultivars (Tables 4 and 5). The highest value of the total chlorophyll and carotenoid content (from 11.7 – 16.1 and 0.35 – 0.41mg g^{-1} respectively) were observed in Granada at NPK compared to control (Tables 4 and 5). According to Sridhar (1986) and Kiline *et al.* (2005), plant parts of WL and PM have higher macro elements and trace element contents. Maiti and Jana (1985) demonstrated that the supply of P is usually associated with increased root density and proliferation which aid in extensive exploration and supply of nutrients and water to the growing plant parts, resulting in increased growth, total chlorophyll and carotenoid content, thereby ensuring more seed and matter yield. Nitrogen is a component of chlorophyll. When N is deficient, leaves will contain relatively little chlorophyll and thus tend to be chlorotic and pale green in color (Edema *et al.*, 2007). K is an important macronutrient for plants, which carries out vital functions in metabolism, growth and stress adaptation (Taffouo *et al.*, 2010). In many plants, a decrease in chlorophyll level under K deficiency has been reported (Taffouo *et al.*, 2010). According to Amtmann and al. (2006), a lack of K will impede the establishment of H^+ gradients, inhibit the activity of photosynthetic enzymes and disturb source-sink transport of sugar which have an impact on rates of photosynthesis. NaCl effect on the total chlorophyll and carotenoid content is shown in Tables 4 and 5. Salinity at 50mm NaCl decreased significantly ($p<0.05$) the total chlorophyll from 11.7 – 8.2mg g^{-1}; 16.1 – 13.8mg g^{-1}; 24.4 – 20.5mg g^{-1}; 27.4 – 22.9mg g^{-1} at control, NPK, 12 t ha^{-1} of WL and PM respectively and carotenoid content from 0.35 – 0.19mg g^{-1}; 0.41 – 0.29mg g^{-1}; 0.69 – 0.51mg g^{-1}; 0.72 – 0.55mg g^{-1} at control, NPK, 12 t ha^{-1} WL and PM respectively content in Granada (Tables 4 and 5).

In agreement with these data, Dorais and al. (2000) showed that CA in tomato fruit was signifcantly decreased under salt stress. Thus, under the prevailing experimental conditions the decrease in CA contents may relate to the decrease in photosynthetic processes under salinity.

A possible explanation would be that salinity may inhibit or upregulate the biosynthetic pathway of carotenoids via inhibition of the genes encoding enzymes related to β-carotene (Dumas *et al.*, 2003). Recently, Babu *et al.* (2011) reported that salt stress caused an inhibition in the expression of the gene encoded for lycopene β-cyclase, the enzyme that converts lycopene to beta carotene. The depressive effect of salt was less marked on leaf CHL content in 'Granada' compared to 'Nobili', 'Goliath' and untreated plants. This effect of salt was attributed to salt-induced weakening of protein-pigment-lipid complex (Strogonov, 1970) or increased chlorophyllase enzyme activity (Sivtsev, 1973). CHL degrades depending on the degree of salt levels in the soil solution, especially in extreme salt stress (10 dS m^{-1}) (Giri *et al.*, 2003), causing to reduce net photosynthetic rate, especially in extreme salt stress (Takemura *et al.*, 2000). Similar results were reported by Turan *et al.* (2007) with lentil plants.

Table 4. Effects of water lettuce and poultry manure fertilization rates on growth characters and total chlorophyll concentrations (mg g-1) of pepper (16 WAS).

				Growth parameters			
Cultivars	Irrigation	Nutrient sources	Treatment (t ha-1)	Plant heigth (cm)	Total leaf area (cm^2)	Number of leaf	Chl (a+b) (mg g-1 FW
		Control	0	48.2±0.71e	356.3±2.24ef	36.6±0.12h	11.7±0.91e
		NPK	0.1	53.1±0.82c	360.3±3.01e	41.4±0.16f	16.1±0.08c
			3	52.9±0.81d	364.5±3.21d	44.2±0.23f	16.9±0.07c
		Water	6	56.3±0.93c	369.1±3.33c	48.2±0.41e	20.8±0/11b
	Tap water	lettuce	12	58.8±0.88b	375.6±2.67ab	54.5±0.21c	24.4±0/12a
			3	53.6±0.76c	360.3±2.34e	47.6±0.32e	17.5±0.09c
		Poultry	6	56.7±0.67c	366.4±2.88cd	55.5±0.28bc	21.8±0.13b
Granada		manure	12	61.6±0.59a	380.9±3.45a	64.5±0.25a	27.4±0.07a
		Control	0	44..5±0.62	354.3±3.12f	31.5±0.17i	8.2±0.11e
	Tap water	NPK	0.1	48.2±0.73e	357.3±2.88e	36.1±0.44h	13.8±0.09d
	+ 50mm		3	49.6±0.75d	363.9±4.01d	38.5±0.59g	14.3±0.14d
	NaCl	Water	6	51.1±0.82d	365.7±3.45cd	41.5±038f	16.9±0.06c
		lettuce	12	53.5±0.78c	368.2±2.66c	45.7±0.58e	20.5±0.05b
		Poultry	3	51.6±0.84d	358.3±2.33e	39.4±0.62g	14.7±0.11d
		manure	6	54.4±0.79c	364.4±3.04d	44.5±0.49f	18.6±0.12c
			12	55.1±0.76c	369.5±3.23c	47.1±0.76e	22.9±0.11b
	Tap water	Control	0	49.8±0.81d	354.3±2.99f	31.4±0.42i	9.9±0.09e
		NPK	0.1	53.3±0.55c	357.4±3.11e	35.5±0.76h	13.3±0.15d
			3	54.4±0.57c	360.5±2.34e	39.7±0.87g	14.4±0.17d
		Water	6	56.5±0.76c	364.4±2.66d	43.9±0.67f	16.9±0.12c
		lettuce	12	60.9±0.68b	370.8±2.55bc	47.7±0.42e	19.8±0.18b
Nobili		Poultry	3	55.5±0.82c	363.3±1.34d	43.8±0.64f	14.3±0.14d
		manure	6	58.3±0.85b	369.3±3.44c	50.1±0.63d	16.7±0.13c
			12	64.5±0.78a	373.5±1.29b	54.2±0.67c	21.3±0.16b

Cultivars	Irrigation	Nutrient sources	Treatment (t ha-1)	Growth parameters Plant heigth (cm)	Total leaf area (cm²)	Number of leaf	Chl (a+b) (mg g-1 FW
		Control	0	45.7±0.82e	351.4±1.87f	28..8±0.76j	6.6±0.19f
		NPK	0.1	49.6±0.49d	356.7±2.35ef	33.2±0.66h	10.9±0.23e
	Tap water		3	50.5±0.58d	360.1±2.45e	35.6±0.54h	13.3±0.21d
	+ 50mm	Water	6	49.3±0.66d	362.8±2.18d	37.7±0.65g	14.8±0.31d
	NaCl	lettuce	12	54.1±0.74c	361.5±2.76de	40.9±0.49g	15.9±0.21d
		Poultry	3	50.2±0.69d	359.3±2.87e	36.8±0.38h	12.5±0.25d
		manure	6	53.4±0.77c	363.5±1.98d	40.2±0.35g	14.1±0.22d
			12	56.8±0.56c	366.4±1.78c	42.5±0.65f	16.3±0.11c
		Control	0	47.6±0.77e	349.8±2.08g	30.2±0.28i	7.8±0.15f
		NPK	0.1	52.5±0.68d	351.1±2.22f	32.3±0.26i	11.4±0.18e
			3	53.3±0.49c	355.4±2.36ef	36.4±0.33h	11.8±0.21e
	Tap water	Water	6	55.5±0.55c	369.5±2.07c	40.2±0.31g	12.3±0.23d
		lettuce	12	58.4±0.53b	368.7±1.68c	46.5±0.41e	13.4±0.17d
		Poultry	3	54.8±0.63c	357.6±1.89e	38.7±0.32g	12.8±0.15d
		manure	6	57.4±0.74b	364.8±3.02d	44.9±0.43f	13.8±0.22d
			12	59.2±0.77b	371.3±3.26b	51.6±0.44d	16.1±0.27c
Goliath		Control	0	43.8±0.43f	346.4±3.04g	25.3±0.56j	5.4±0.24f
		NPK	0.1	47.4±0.52e	348.2±322g	29.5±0.44i	9.7±0.22e
			3	48..3±0.57e	351.4±3.11f	32.2±0.34i	9.3±0.21e
	Tap water	Water	6	53.1±0.55c	354.3±3.15f	35.3±0.36h	10.4±0.17e
	+ 50mm	lettuce	12	52.8±0.51d	356.3±3.06e	36.4±0.31h	11.8±0.16e
	NaCl	Poultry	3	49.7±0.64d	353.8±2.32f	33.6±0.26h	10.3±0.11e
		manure	6	53.4±0.68c	357.9±2.58e	37.5±0.33g	12.7±012d
			12	56.2±0.77c	360.7±3.01e	36.9±0.46h	11.9±0.21e
Two way ANOVA results							
Cultivars (C)				NS	*	*	*
Salt treatment (S)				*	*	*	*
Water lettuce (WL)				*	**	*	**
Poultry manure (PM)				**	**	**	**
Interaction C x S				*	*	*	NS
Interaction WL x S				*	*	*	*
Interaction PM x S				*	*	*	*
Interaction WL x C				*	*	*	*
Interaction PM x C				*	**	**	*

Values shown are means (n=5) ± SD; within columns, means followed by different letter are significantly different ($p < 0.05$).

**, * significant at 1 and 5% probability levels, respectively, NS not significant

Table 5. Effects of water lettuce and poultry manure fertilization rates on fruit quality of pepper (16 WAS).

Cultivars	Irrigation	Nutrient sources	Treatment (t ha-1)	FD (cm)	FL (cm)	TF (mm)	FFW(g)	CA (mg g-1)
		Control	0	5.8±0.02b	13.6±0.12c	4.8±0.02b	35.5±0.22e	0.35±0.01h
		NPK	0.1	7.3±0.03ab	17.2±0.13b	5.3±0.01a	40.7±0.21d	0.41±0.02g
		Water	3	7.7±0.02ab	18.8±0.21b	5.7±0.06a	41.6±0.24c	0.49±0.03e
		lettuce	6	8.1±0.04a	19.2±014b	5.9±0.08a	43.6±0.18c	0.55±0.04d
	Tap water		12	9.5±0.03a	21.5±0.17a	6.2±0.09a	45.7±0.19b	0.68±0.02a
		Poultry	3	7.6±0.06ab	18.3±0.22b	6.0±0.03a	42.6±0.26c	0.48±0.05e
		manure	6	8.4±0.04a	19.6±0.24b	6.3±0.04a	46.2±0.29b	0.58±0.06c
Granada			12	10.2±0.05a	23.2±0.21a	6.5±0.01a	52.8±0.32a	0.72±0.03a
		Control	0	3.9±0.02bc	9.6±0.27d	3.6±0.06b	30.7±0.17f	0.19±0.06k
	Tap	NPK	0.1	5.8±0.07b	12.9±0.29cd	5.8±0.08a	34.7±0.24e	0.29±0.03i
	water +	Water	3	6.3±0.07b	13.4±0.18c	5.1±0.09a	36.2±0.26e	0.32±0.08i
	50mm	lettuce	6	6.8±0.03b	14.8±0.16c	5.6±0.05a	38.3±0.23d	0.43±0.04f
	NaCl		12	6.5±0.06b	16.2±0.13bc	5.4±0.11a	40.7±0.22d	0.51±0.05e
		Poultry	3	5.7±0.7b	14.6±0.14c	5.2±0.12a	36.3±0.18e	0.34±0.09h
		manure	6	6.5±0.03b	16.2±0.21bc	5.6±0.09a	38.9±0.19d	0.49±0.02e
			12	7.7±0.04ab	17.8±0.23b	5.8±0.13a	41.5±0.24c	0.55±0.03d
		Control	0	6.8±0.02b	12.1±0.19cd	5.3±0.07a	29.7±0.26f	0.28±0.06i
		NPK	0.1	8.3±0.08a	16.7±0.18bc	5.6±0.05a	33.3±0.27e	0.29±0.08i
		Water	3	8.5±0.06a	17.3±0.16b	5.8±0.08a	34.1±0.23e	0.34±0.11h
	Tap	lettuce	6	8.9±0.08a	18.8±0.18b	6.3±0.09a	35.7±0.28e	0.38±0.08g
	water		12	9.4±0.11a	19.1±0.25b	6.5±0.11a	37.8±0.21d	0.56±0.12d
		Poultry	3	8.4±0.09a	17.4±0.22b	5.9±0.07a	33.8±0.21e	0.32±0.02i
		manure	6	9.8±0.08a	19.1±0.21b	6.3±0.12a	36.3±0.25e	0.44±0.04f
Nobili			12	11.8±0.12a	20.9±0.19ab	6.8±0.11a	39.2±0.27d	0.52±0.02e
		Control	0	4.40.11±b	8.5±0.15de	3.1±0.09b	26.8±0.27g	0.15±0.07l
		NPK	0.1	6.7±0.13b	12.8±0.28cd	5.3±0.08a	30.3±0.22f	0.26±0.14j
	Tap	Water	3	6.9±0.07b	13.2±0.23c	5.6±0.09a	30.3±0.21f	0.29±0.12i

Cultivars	Irrigation	Nutrient sources	Treatment (t ha-1)	FD (cm)	FL (cm)	TF (mm)	FFW(g)	CA (mg g-1)
Goliath	water + 50mm NaCl	lettuce	6	7.3±0.13ab	14.7±0.25c	5.9±0.12a	32.4±0.24f	0.33±0.01h
			12	7.8±0.06ab	14.9±0.19c	6.1±0.13a	31.8±0.27f	0.39±0.16g
		Poultry manure	3	7.1±0.08ab	13.5±0.26c	5.7±0.09a	31.6±0.28f	0.25±0.01j
			6	7.6±0.14ab	15±0.29c	6.2±0.07a	33.7±0.21e	0.33±0.15h
			12	7.9±0.11ab	15.8±0.31c	6.4±0.14a	34.5±0.19e	0.41±0.17g
	Tap water	Control	0	7.3±0.12ab	7.6±0.22e	5.6±0.12a	30.5±0.21f	0.26±0.15j
		NPK	0.1	7.7±0.09ab	11.7±0.18d	5.8±0.06a	34.9±0.16e	0.27±0.11j
		Water lettuce	3	7.9±0.16ab	12.9±0.16cd	6.2±0.05a	34.5±0.18e	0.30±0.13i
			6	8.4±0.12a	14.5±0.17c	6.6±0.09a	37.5±012d	0.39±0.12g
			12	9.2±0.17a	17.5±0.21b	7.2±0.08a	39.8±0.15d	0.47±0.16f
		Poultry manure	3	8.1±0.13a	13.5±0.17c	5.2±0.14a	34.2±0.21e	0.27±0.09j
			6	9.5±0.12a	15.9±0.19c	6.7±0.16a	37.3±018d	0.35±0.07h
			12	11.6±0.18a	19.8±0.23b	7.4±0.07a	42.8±0.19c	0.54±0.12d
	Tap water + 50mm NaCl	Control	0	4.7±0.11b	4.9±0.26ef	5.1±0.11a	25.6±0.26g	0.24±0.08j
		NPK	0.1	6.9±0.14b	8.1±0.25de	3.3±0.13b	30.2±0.24f	0.11±0.12m
		Water lettuce	3	7.2±0.14ab	10.5±0.18d	5.7±0.07a	31.3±0.31f	0.2±0.11k
			6	8.5±0.11a	12.8±0.14cd	5.9±0.06a	32.8±0.32f	0.28±0.13i
			12	7.9±0.09ab	14.4±0.11c	6.4±0.08a	34.1±0.23e	0.32±0.15i
		Poultry manure	3	7.4±0.07ab	10.5±0.15d	5.8±0.13a	32.9±0.25f	0.24±0.12j
			6	8.2±0.11a	13.7±0.16c	6.1±0.11a	31.4±0.27f	0.31±0.13i
			12	8.9±0.13a	15.5±0.13c	6.3±0.12a	34.8±0.26e	0.36±0.11h
Two way ANOVA results								
Cultivars (C)				NS	*	NS	*	*
Salt treatment (S)				*	*	*	*	**
Water lettuce (WL)				*	*	NS	*	*
Poultry manure (PM)				**	**	*	**	**
Interaction C x S				*	*	NS	*	*
Interaction WL x S				NS	*	*	*	**
Interaction PM x S				*	*	*	*	**
Interaction WL x C				NS	NS	NS	*	*
Interaction PM x C				NS	*	NS	*	*

Values shown are means (n=5) ± SD; within columns, means followed by different letter are significantly different ($p < 0.05$).

**, * significant at 1 and 5% probability levels, respectively, NS not significant.

Table 6. Effects of water lettuce and poultry manure fertilization rates on yield component of pepper (16 WAS).

Yield component								
Cultivars	Irrigation	Nutrient sources	Treatment (t ha-1)	NF	NS	FY (t ha-1)	GY (g ha-1)	GW (g)
Granada	Tap water	Control	0	10.7±0.11b	239.8±2.3g	10.2±0.07b	347.2±3.23e	5.6±0.02c
		NPK	0.1	12.5±0.09a	243.1±2.01f	11.6±0.02b	352.5±3.44d	9.5±0.21b
		Water lettuce	3	13.3±0.08a	244.6±3.21f	12.3±0.01b	358.4±3.51c	9.9±0.11b
			6	14.1±0.07a	249.2±4.21e	12.7±0.04b	364.6±2.88b	10.7±0.14b
			12	15.9±0.11a	254.5±3.44d	13.4±0.01b	368.8±3.11a	11.8±0.09a
		Poultry manure	3	13.7±0.09a	247.7±1.78e	11.3±0.08b	360.4±2.78c	10.5±0.06b
			6	15.6±0.07a	255.1±1.98d	12.2±0.03b	366.3±3.44b	11.1±0.05a
			12	17.2±0.08a	261.5±2.32c	14.3±0.08a	371.8±4.32a	14.2±0.14a
	Tap water + 50mm NaCl	Control	0	6.6±0.12c	216±4.55l	7.6±0.02c	339.9±3.66g	4.8±0.21c
		NPK	0.1	9.9±0.06b	220.8±4.12k	8.5±0.04b	344.5±4.55f	8.2±0.22b
		Water lettuce	3	10.4±0.04b	226.9±4.37j	9.3±0.09b	347.1±5.21e	8.6±0.15b
			6	11.8±0.06b	230.6±4.78i	10.6±0.11b	344.6±4.33f	7.1±0.16b
			12	13.5±0.11b	277.2±3.47a	11.7±0.07b	351.7±4.23e	9.6±0.11b
		Poultry manure	3	11±0.13b	228.3±3.88i	9.7±0.12b	349.4±3.45e	8.1±0.08b
			6	11.6±0.09b	237.7±3.79g	11.5±0.08b	354.3±3.34d	9.0±0.09b
			12	14.2±0.12b	261.2±3.65c	12.9±0.06b	356.1±4.88d	10.8±0.18b
Nobili	Tap water	Control	0	9.5±0.11b	185.6±2.87r	7.5±0.14b	311.8±4.11m	4.8±0.23c
		NPK	0.1	13.8±0.14a	191.2±3.76q	10.2±0.05b	316.3±4.67l	8.1±0.26b
		Water lettuce	3	13.2±0.08a	197.6±3.84o	10.9±0.17b	321.6±4.91k	8.6±0.07b
			6	14.1±0.03a	209.7±3.81m	11.3±0.13a	324±3.48j	9.8±0.16b
			12	14.6±0.06a	214.5±3.92l	12.5±0.17a	330.3±3.12i	10.6±0.19b
		Poultry manure	3	11.2±0.11b	207.4±3.97m	10.5±0.18b	323.6±4.66j	8.7±0.21b
			6	12.8±0.15a	210.1±4.01m	11.8±0.11a	329.2±3.45i	9.5±0.23b
			12	15.8±0.21a	216.3±4.25l	13.4±0.14a	337.1±3.88g	11.1±0.14a
	Tap water + 50mm NaCl	Control	0	6.5±0.22c	181.2±4.32s	6.9±0.13c	309.4±3.69m	3.8±0.08c
		NPK	0.1	10.1±0.17b	188.6±2.78q	9.2±0.15b	311.5±3.19m	7.6±0.11b
		Water lettuce	3	10.5±0.18b	194.6±2.88p	9.8±0.11b	315.3±2.77l	8.1±0.14b
			6	9.9±0.08b	191.9±2.69q	10±0.29b	323.6±2.56j	9.4±0.22b
			12	11.5±0.12b	201.3±3.21o	10.4±0.08	320.2±1.89k	8.9±0.31b

Yield component								
Cultivars	Irrigation	Nutrient sources	Treatment (t ha-1)	NF	NS	FY (t ha-1)	GY (g ha-1)	GW (g)
		Poultry manure	3	10.4±0.16b	196.1±3.15p	9.7±0.14b	317.6±1.45k	8.3±0.33b
			6	11.4±0.21b	207.1±3.19m	10.2±0.12b	325.5±1.98j	8.1±0.21b
			12	11.6±0.18b	204.5±3.67n	11.8±0.15a	322.3±3.52j	9.8±0.13b
		Control	0	10.6±0.14b	227.2±3.72i	10.3±0.08b	330.4±2.77i	4.9±0.16c
		NPK	0.1	14.2±0.19a	231.5±3.79i	10.7±0.12b	336.6±3.68h	7.3±0.19b
	Tap water	Water lettuce	3	14.8±0.21a	236.1±3.84h	11.3±0.13a	340.4±3.65g	8.9±0.12b
			6	14.7±0.08a	241.3±4.11g	11.6±0.17a	345.1±3.45f	9.4±0.33b
			12	15.8±0.06a	248.2±4.12e	12±0.19a	350.7±3.48e	8.3±0.34b
		Poultry manure	3	14.6±0.16a	240.3±2.98g	11.6±0.21a	343.3±2.88f	7.2±0.26b
			6	15.3±0.13a	251.1±2.86e	12.3±0.22a	350.5±3.27e	8.8±0.28b
			12	16.2±0.18a	266.3±2.76b	14.5±0.13a	356.4±2.18d	10.8±0.36b
Goliath		Control	0	7.7±0.22a	223.2±2.69j	7.8±0.88b	326.3±5.66j	3.5±0.12c
	Tap water + 50mm NaCl	NPK	0.1	11.3±0.21	229.7±3.26i	10.3±0.48b	331.2±5.23i	7.7±0.17b
		Water lettuce	3	11.9±0.12c	235.9±3.88h	10.5±0.57b	334.2±4.37h	8.1±0.17b
			6	12.1±0.14a	233.2±2.59h	10.8±0.88b	340.7±3.87g	8.7±0.19b
			12	11.8±0.09b	240.3±3.77g	11±0.76a	343.5±4.25f	9.6±0.22b
		Poultry manure	3	12.4±0.17a	231.6±2.57i	10.6±0.32b	336.7±4.11h	8.5±0.16b
			6	12.1±0.16a	229±2.44i	11.3±0.54a	347.2±3.93e	10.8±0.22b
			12	12.9±0.21a	238.1±2.76g	11.5±0.48a	344.5±3.91f	9.7±0.35b
Two way ANOVA results								
Cultivars (C)				NS	*	NS	*	*
Salt treatment (S)				*	*	*	*	NS
Water lettuce (WL)				*	*	*	*	*
Poultry manure (PM)				**	**	*	**	**
Interaction C x S				*	*	*	*	NS
Interaction WL x S				*	*	*	*	*
Interaction PM x S				*	*	*	*	*
Interaction WL x C				NS	*	NS	*	NS
Interaction PM x C				NS	**	*	**	*

Values shown are means (n=5) ± SD; within columns, means followed by different letter are significantly different ($p < 0.05$). **, * significant at 1 and 5% probability levels, respectively, NS not significant.

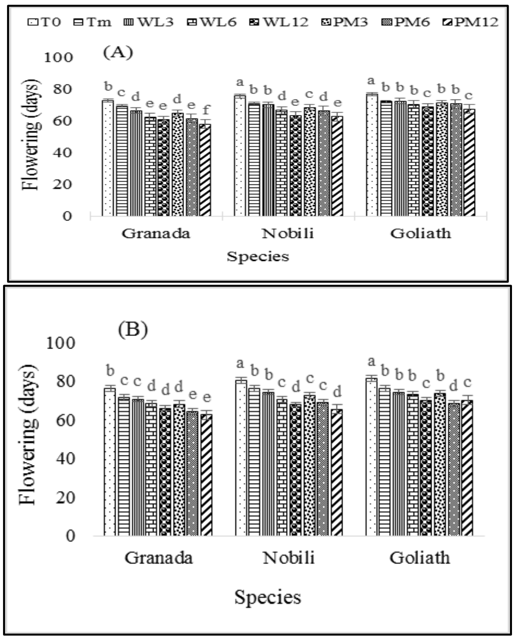

Fig. 1. Effects of organic and inorganic fertilizers application and salinity on flowering in pepper cultivars at the mature stage**.** (A): control (water tap); (B): water tap+50mm NaCl; To: control; Tm: NPK; WL: water lettuce; PM: poultry manure. Bars are means (n=5) ± SD. Means followed by different letter are significantly different ($p < 0.05$).

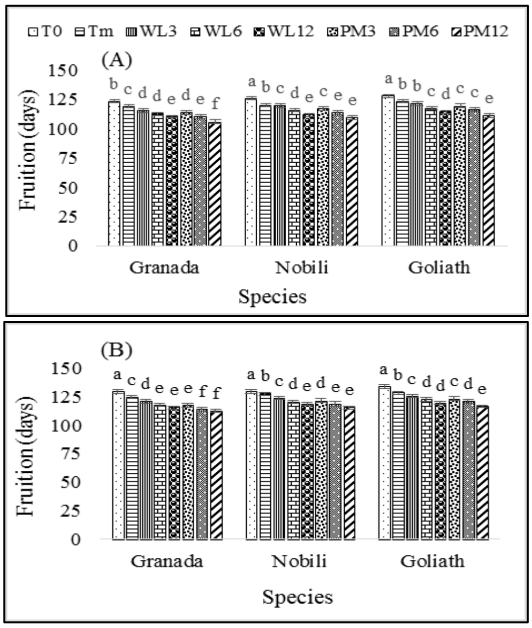

Fig. 2. Effects of organic and inorganic fertilizers application and salinity on fruition in pepper cultivars at the mature stage**.** (A): control (water tap); (B): water tap+50mm NaCl; To: control; Tm: NPK; WL: water lettuce; PM: poultry manure. Bars are means (n=5) ± SD. Means followed by different letter are significantly different ($p < 0.05$).

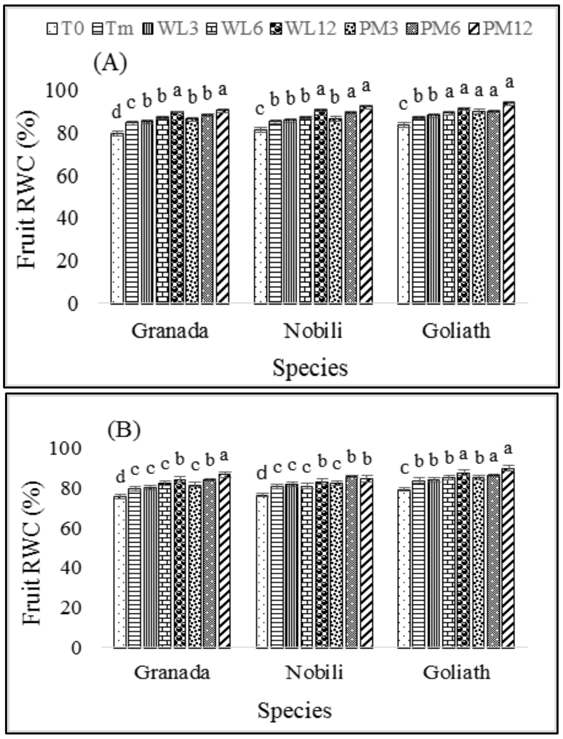

Fig. 3. Effects of organic and inorganic fertilizers and salinity on fruit water content in pepper cultivars at the mature stage**.** (A): control (water tap); (B): water tap+50mm NaCl; T0: control; Tm: NPK; WL: water lettuce; PM: poultry manure. Bars are means (n=5) ± SD. Means followed by different letter are significantly different ($p < 0.05$).

Conclusion

Considering the above mentioned results, it may be concluded that, the growth and yield parameters of all pepper cultivars gradually decreased by the increase of salinity levels and this reduction rate was decreased by exogenous supply of WL, PM and NPK. Among the fertilizers levels, 12 t ha^{-1} of PW application showed the highest result in growth and yield parameters in all cultivar as compared to 12 t ha^{-1} of WL and at last NPK. The Granada showed better growth and yield than Nobili and Goliath in this condition revealing a greater response of this landrace to organic and mineral fertilization with or whitout the salt stress. Granada can be considered as an important companion crop for the development of smallholder agriculture in coastal region of Cameroon. Therefore, this experiment suggests that PM and WL can effectively mitigate the deleterious effect of NaCl stress in pepper cultivation. PM and WL can be recommended for farmers to use in their fields for alleviating salt stress and can serve as a suitable alternative to chemical fertilize in coastal region of Cameroon.

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Abbreviations

Calcium-Ca; plant height-PH; total leaf area-TLA; chlorophyll-CHL; days after planting-DAP; days after sowing-DAS; magnesium-Mg; number of leaf-NL; number of ripe fruit per plant-NF; fruit length-FL; fruit diameter-FD; sodium-Na; fruit yield-FY; grain yield-GY; 1000 grain weight-GW; flowering-FLO; fruition-FRU; relative water content-RWC; number seeds-NS; organic carbon-C; nitrogen-N; sulfate-S; phosphorus-P; potassium-K; relative water content-RWC; fruit dry weight-FDW; fruit fresh weight-FFW; thickness of fruit-TF; week after sowing-WAS.

References

Abdul Qados AMS. 2011. Effect of salt stress on plant growth and metabolism of bean plant (*Vicia faba* L.). Journal Saudi Social Agriculture Science, **10,** 7-15.

Adedeji O, Taiwo KA, Akanbi CT, Ajani R. 2006. Physiochemical properties of four tomato cultivars growing in Nigeria. Journal Food Process Pres **30,** 79-86.

Alabi DA. 2006. Effect of fertilizer phosphorus and poultry droppings treatments on growth and nutrient components of pepper (*Capsicum annuum* L.). African Journal of Biotechnology, **5(8),** 671-677.

Amtmann A, Hammond JP, Armengaud P, White PJ. 2006. Nutrient sensing and signaling in plants: potassium and phosphorus. Adv. Botanical Res **43,** 209-257.

Ashraf M. 2004. Some important physiological selection criteria for salt tolerance in plants. Flora, **199,** 361-376.

Ayuke FO, Rao MR, Swift MJ, Opondo-Mbaim L. 2004. Effects of Organic and Inorganic Fertilizers on soil mineral nitrogen and maize yields in western Kenya. In: Managing nutrient cycles to sustain soil fertility in Sub-Saharan Africa. Bationo, A. (Ed.)., Academy Science Publishers (ASP), AfNet-CIAT, Nairobi, Kenya **pp,** 65-76.

Babu MA, Singh D, Gothandam KM. 2011. Effect of salt stress on expression of carotenoid pathway genes in tomato. Journal of Stress Physiol and Biochemistry, **7,** 87–94.

Bala HMB, Ogunlela VB, Tanimu B, Kuchinda NC. 2011. Response of two groundnut (*Arachis hypogea* L.) varieties tosowing date and NPK fertilizer rate in a semi-arid environment: growth and growth attributes. Asian Journal of Crop Science **3,** 141-150.

Boateng SA, Zickermann J, Kornahrens M. 2006. Poultry manure effect on growth and yield of maize. West African Journal of Ecology **9,** 1-11.

Bosland PW, Votava EJ. 2000. Peppers, Vegetables and Spices *Capsicum*. CABI Publishing. New York. 198 p.

Chookhampaeng S. 2011. The effect of salt stress on growth, chlorophyll content, proline content and antioxidative enzymes of pepper (*Capsicum annuun* L.) seedling. European Journal of Scientific Research **49,** 103-109.

Christianson CB, Vlek PLG. 1991. Alleviating soil fertility constraints to food production in West Africa. Efficiency of N fertilizer applied to food crops. In: Alleviating soil fertility constraints to increase crop production in West Africa. Mokwunye, U. (Ed.)., Kluwer Academic Publishers, Dordrecht, Netherlands pp, 45-59.

Deinlein U, Stephan AB, Horie T, Luo W, Xu G, Schroeder JI. 2014. Plant salt-tolerance mechanisms. Trends in Plant Science **19,** 371-379.

Dorais M, Turcotte G, Papadopoulos AP, Hao X, Gosselin A. 2000. Control of tomato fruit quality and flavour by EC and water management. Agric and Agri-Food Canada Report pp, 18-21.

Dumas Y, Dadomo M, Di Lucca G, Grolier P. 2003. Effects of environmental factors and agricultural techniques on antioxidant content of tomatoes. Journal of Science Food and Agriculture **83,** 369-382.

Edema NE, Okoloko GE, Agbogidi MO. 2007. Physioco-chemical characteristics of the water soluble fraction of ogini well-head crude oil and the effects on *Pistia stratiotes* L. in (Water lettuce). Am-Euras. Journal of Agriculture Environmental Science **2,** 633-638.

Gandonou GC, Skali B, Senhaji N. 2015. Sugarcane (*Saccharum* sp.) salt tolerance at various developmental levels. In: Chakraborty U., Chakraborty B., Editors, Abiotic Stresses in Crop Plants, CABI Publishing, United Kingdom, ISBN-13: 978-1-78064-373-1: 102-111.

Giri B, Kapoor R, Mukerjikg. 2003. Influence of arbuscular mycorrhizal fungi and salinity on growth, biomass, and mineral nutrition of *Acacia auriculiformis*. Biology and Fertility of Soils **38,** 170-175.

Grattan SR, Zeng LH, Shannonmc, Roberts SR. 2002. Rice is more sensitive to salinity than previously thought. California-Agriculture **56 (6),** 189-195.

Hajiboland R, Aliasgharzadeh A, Laiegh SF, Poschenrieder C. 2010. Colonization with arbuscular mycorrhizal fungi improves salinity tolerance of tomato (*Solanum lycopersicum L.*) plants. Plant Soil **331,** 313-327.

Hosseini G, Thengane RJ. 2007. Salinity tolerance in cotton (*Gossypium hirsutum* L.) genotypes. International Journal of Botany **3(1),** 48-55.

Hossner LR, Juo ASR. 1999. Soil nutrient management for sustained food crop production in upland farming systems in the tropic. Food and fertilizer technology centre, Taiwan.

Howard L, Talcott RST, Brenes CH, Villalon B. 2000. Changes in phytochemical and antioxidant activity of selected pepper cultivars (*Capsicum species*) as influenced by maturity. Journal of Agriculture Food Chemistry **48,** 1713-1720.

Huez-López MA, Ulery AL, Samani Z, Picchioni G, Flynn RP. 2011. Response of chile pepper (*Capsicum annuum* L.) to salt stress and organic and inorganic nitrogen sources: I. Growth and yield. Tropical and Subtropical Agroecosystems **14,** 137-147.

Jaleel CA, Sankar B, Sridharan R, Panneerselvam R. 2008. Soil salinity alter growth, chlorophyll content, and the secondary metabolite accumulation in Catharanthusroseus. Turk J. Biol **32,** 79-83.

Jemo M, Nolte C, Tchienkoua M, Abaidoo RC. 2010. Biological nitrogen fixation potential by soybeans in two low-P soils of southern Cameroon. Nutr. Cycl. Agroecocyst **88,** 49-58.

Khayyat M, Tafazoli E, Eshghi S, Rahemi M, Rajaee S. 2007. Salinity, supplementary calcium and potassium effects on fruit yield and quality of strawberry (*Fragaria ananassa* Duch.). Am-Eur J Agric Environ Sci **2,** 539-544.

Khoshsokan F, Babalar M, Chaghazardi HR, Fatahimoghasam MR. 2012. Effect of salinity and drought stress on germination indices of two thymus species. Cercetări Agronomice in Moldova **1(149),** 27-35.

Kiline A, Bilgin A, Yalcin Kutbay E, HG. 2005. Macroelement (N, P, K) contents of *Arum euxinum* R. mill during vegetable and generative growth phases. Pak. J. Biol. Sci 267-272.

Kumar N, Krishnamoorty V, Nalina L, Soorianathasundharam K. 2002. A new factor for estimating total leaf area in banana. InfoMusa **11,** 42-43.

Lecontemc, Mazzarino PS, Satti P, Crego MP. 2011. Nitrogen and phosphorus release from poultry manure composts: the role of carbonaceous bulking agents and compost particles sizes. Biol. Fertil. Soils, **47,** 897-906.

Lichtenthaler HK, Wellburn AR. 1983. Determinations of total carotenoids and chlorophylls *a* and *b* of leaf extracts in different solvents. In Biochemical Society Transactions, vol **11,** pp, 591-592.

Lower SS, Orianscm. 2003. Soil organic, nutrients and water availability interact to influence willow growth and chemistry but not leaf beetle performance. Entomol. Exp. Apl., **107,** 69-79.

Lv M, Li Z, Che Y, Liu M. 2011. Soil organic, nutrients, microbial biomass and grain yield of rice (*Orysa sativa* L.) after 18 years of fertilizer application to an infertile paddy soil. Biol. Fertil. Soils **47,** 777-783.

Ly M, Kumar D, Diouf M, Nautiyal S, Diop T. 2014. Effet de la salinité sur la croissance et la production de biomasse de deux provenances de *Jatropha curcas* L. cultivés en serre. International Journal of Biological and Chemical Sciences **8(1),** p. 46-56.

Maaouia-Houimli SI, Denden M, Dridi-Mouhandes B, Mansour-gueddes SB. 2011. Caractéristiques de la croissance et de la production en fruits chez trois variétés de piment (*Capsicum annuum* L.) sous stress salin. Tropicultura, **29(2),** p. 75-81.

Machado RMA, Serralheiro RP. 2017. Soil salinity: Effect on vegetable crop growth. Management practices to prevent and mitigate soil salinization. Horticulturae **3(30),** 1-13.

Maiti DD, Jana PK. 1985. Effects of different levels of nitrogen and phosphorus on yield and yield attributes of sesame1. Oilseeds Res **2,** 252-259.

Manu A, Bationo A, Geiger SC. 1991. Fertility status of millet producing soils of West Africa with emphasis on phosphorus. Soil Science **152,** 315-320.

Marschner H. 1986. The mineral nutrition of higher plants. 1st Edn., Academic Press, New York.

Marschner P, mc Neill A. 2011. Legume residue influence arbuscular mycorrhizal colonization and P uptake by wheat. Biol. Fertil. Soils **47,** 701-707.

Materska M, Perucka I. 2005. Antioxidant activity of the main phenoliccompounds isolated from hot pepper fruit (*Capsicum annuum* L.). Journal of Agriculture and Food Chemistry **53,** 1750-1756.

Meguekam TL, Taffouo VD, Marius-Nicusor G, Maria ZM, Youmbi E, Akoa A. 2014. Differential responses of growth, chlorophyll content, lipid peroxidation and accumulation of compatible solutes to salt stress in peanut (*Arachis hypogaea* L.) cultivars. African Journal of Biotechnology **13,** 4577-4585.

Mudgal V, Madaan N, Mudgal A. 2010. Biochemical mechanisms of salt tolerance in plants: a review. International Journal of Botany **6,** 136-143.

Munns R. 2002. Comparative physiology of salt and water stress. Plant, cell and Environment **25,** 239-250.

Nabloussi A, El Fechtali M, Lyagoubi S. 2008. Agronomic and technological evaluation of a world safflower collection in Morocco conditions. Proceed. 7ème Conf. Internat. Carthame, Waga Waga, Australie 3-6 Novembre 2008.

Navarro JM, Garrido C, Flores P, Martinez V. 2010. The effect of salinity on yield and fruit quality of pepper grown in perlite. Spanish Journal of Agricultural Research **8,** 142-150.

Nziguheba G, Merckx R, Palm CA, Mutuo P. 2004. Combined use of Tithonia diversifolia and Inorganic fertilizers for improving maize production in a phosphorus deficient soil in western Kenya. In: managing nutrient cycles to sustain soil fertility in Sub-Saharan Africa, Bationo, A. (Ed.). Academy Science Publishers, Nairobi, Kenya pp, 329-346.

Odendo M, Ojiem J, Okwosa E. 2004. Potential for adoption of legume green manure on smallholder farms in western Kenya. In: Managing nutrient cycles to sustain soil fertility in Sub-saharan African, Bation, A. (Ed.). Academy Science Publishers, Nairobi, Kenya pp, 557-570.

Okalebo JR, Gathua WK, Woomer PL. 1993. Laboratory methods of soil and plant analysis: a working manual In Soil Biology and Fertility, Soil Science Society of East Africa, Kari, UNESCO-ROSTA Naïrobi, Kenya 88 p.

Parvin K, Ahamed KU, Islammm, Haque MN. 2015. Response of tomato plant under salt stress: Role of exogenous calcium. Journal of Plant Sciences **10,** 222-233.

Perkins HF. 1964. Chicken manure: Its Production, Composition and Use as a Fertilizer. *Georgea* Agricultural Experiment Stations. University of Georgea College of Agriculture, Dahlonega, USA. Pages 123.

Pompeiano A, Di Patrizio E, Volterrani M, Scartazza A, Guglielminetti L. 2016. Growth responses and physiological traits of seashore paspalum subjected to short-term salinity stress and recovery. Agr. Water Manag **163,** 57-65.

Purseglove JW. 1968. Tropical dicotyledonous crop. Longman scientific and technical, Singapore pp, 252-263.

R'him T, Tlili I, Hnan I, Ilahy R, Benali A, Jebari H. 2013. Effet du stress salin sur le comportement physiologique et métabolique de trois variétés de piment (*Capsicum annuum* L.). Journal of Applied BioSciences **66,** 5060-5069.

Rahman MA, Haque E, Hasanuzzaman M, Muhuri SR, Shahid IZ. 2011. Evaluation of antinociceptive and antidiarrhoeal properties of *Pistia stratiotes* (Araceae) leaves. J. Pharmacol. Toxicol **6,** 596-601.

Rahman MJ, Uddin MS, Bagum SA, Mondol AT, Zamanmm MA. 2006. Effect of mulches on the growth and yield of tomato in the coastal area of Bangladesh under rainfed condition. Int J Sustain Crop Prod **1,** 6-10.

Rahman MS, Al-Rizeiqi MH, Guizani N, Al Ruzaiqi MS, Al-Aamri AH, Zainab S. 2013. Stability of vitamin C in fresh and freeze-dried Capsicum strored at different temperatures. Journal of Food Science and Technology **52(3),** 1691-1697.

Rubio JS, Garcia-Sanchez F, Rubio F, Martinez V. 2009. Yield, blossom-end rot incidence, and fruit quality in pepper plants under moderate salinity are affected by K+ and Ca2+ fertilization. Sci. Horticulturae **119,** 79-87.

Saeed R, Ahmad R. 2009. Vegetative growth of tomato as affected by the application of organic mulch and gypsum under saline rhizosphere. Pak J Bot **41,** 3093-3105.

Sakr MT, El-Emery ME, Fouda RA, Mowafy MA. 2007. Role of some antioxidants in alleviating soil salinity stress. Journal of Agricultural Science, Mansoura University **32,** 9751- 9763.

Sakr MT, El-Hadidy M, Abo El-Kheer AM, Farouk S. 2004. Physiological studies of some osmo-regulator on kanulla. International Conversation Microbiology and Biotechnology in Africa and Arab Regions, 27th to 29th pp, 295-321.

Savvas D, Gruda N. 2018. Application of soilless culture technologies in the modern greenhouse industry—A review. Eur. J. Hortic. Sci **83,** 280-293.

Schomberg HH, Endale DM, Jenkins MB, Fisher DS. 2011. Nutrient source and tillage influences on nitrogen availability in a Southern Piedmonts corn cropping system. Biol. Fertil. Soils **47,** 823-831.

Sharifa S, Abu-Muriefah. 2015. Effect of Sitosterol on growth, metabolism and protein pattern of pepper (*Capsicum annuum* L) plants grown under salt stress conditions. Int. J. Agri. Crop. Sci., Vol **8(2),** 94-106.

Shelu HE, JD. Kwari Sandabe MK. 2010. Effects of N, P, K fertilizers on yield, content and uptake of N, P and K by sesame (*Sesamum indicum*). Int. J. Agric. Biol **12,** 845-850.

Shoyakubov RS, Aitmetova KI. 1999. Chemical composition of Eichornia crassipes and Pista stratiotes. Chem. Nat. Compd **35,** 227-228.

Shrivastava P, Kumar R. 2015. Soil salinity: A serious environmental issue and plant growth promoting bacteria as one of the tools for its alleviation. Saudi Journal of Biological Sciences **22,** 123-131.

Sivtsev MV, Ponomareva SA, Kuznetsova EA. 1973. Effect of salinization and a herbicide on chlorophyllase activity in tomato leaves. Fiziologiya Rastenii **20(1),** 62-65.

Sridhar MKC. 1986. Trace element composition of *Pistia stratiotes* L. in a polluted lake in Nigeria. Hydrobiologia **131,** 273-276.

Strogonov BP, Kabanov W, Lapina LP, Prykhodko LS. 1970. Structure and function of plant cells under salinity conditions. Nauka Publishing House Moscow.

Taffouo VD, Djiotie NL, Kenne M, Din N, Priso JR, Dibong S, Akoa A. 2008. Effect of salt stress on physiological and agronomic characteristics of three tropical cucurbit species. Journal of Applied Bioscience **10,** 434-441.

Taffouo VD, Kouamou JK, Ngalangue LMT, Ndjeudji BAN, Amougou A. 2009. Effect of salinity stress on growth, ions partitioning and yield of some cowpea (*Vigna unguiculata* L. walp.) cultivars. International Journal of Botany **5(2),** 135-145.

Taffouo VD, Wamba FO, Youmbi E, Nono GN, Amougou A. 2010. Growth, yield, water status and ionic distribution response of three bambara groundnut (*Vigna subterranea* L. verdc.) landraces grown under saline conditions. International Journal of Botany **6(1),** 53-58.

Takemura T, Hanagata N, Suugihara K, Baba S, Karube I, Dubinsky Z. 2000. Physiological and biochemical responses to salt stress in the mangrove, *Bruguiera gymnorrhiza*. Aquatic Botany **68,** 15-28.

Taleisnik E, Peyrano G, Arias C. 1997. Response of *Chloris gayana* cultivars to salinity. 1. Germination and early vegetative growth. Trop. Grassl **31,** 232-240.

Turan MA, Turkmen N, Taban N. 2007. Effect of NaCl on stomacal resistance and proline, chlorophyll, Na, Cl and K concentrations of Lentil plants. Journal of Agronomy **6,** 378-381.

Uzo JO. 1982. Inheritance of Nsukka yellow pepper, aroma, ascorbic acid and carotene in *Capsicum annuum* L. Crop Res (Hort. Res.) **22,** 77-83.

Van Zandt P, Mopper S. 2002. Delayed and carryover effects of salinity on flowering in *Iris hexagona* (Iridaceae). American Journal of Botany **89(11),** 1847-1851.

Wahyuni Y, Ballester AR, Sudarmonowati E, Bino RJ, Bovy AG. 2013. Secondary metabolites of *Capsicum* species and their importance in the human diet. J. Nat. Prod **76(4),** 783-793.

Waldrip H, He Z, Erich S. 2011. Effects of poultry manure amendment on phosphorus uptake by ryegrass, soil phosphorus fractions and phosphatase activity. Biol. Fertil. Soils **47,** 407-418.

Walkley A, Black IA. 1934. An examination of the Degtjareff method for determining soil organic matter and a proposed modification of the chromic acid titration method. Soil Sci **37,** 29-38.

Yildirim E, Karlidag H, Turan M. 2009. Mitigation of salt stress in strawberry by foliar K, Ca andmg nutrient supply. Plant Soil Environ **55,** 213-221.

Zaibunnisa A, Khan MA, Flowers TJ, Ahmad R, Malik KA. 2002. Causes of sterility in rice under salinity stress. In: Ahmad, R. (Ed.) Prospects for saline-agriculture. Kluwer. The Netherlands 177-187.

ANNEX

Table 7. Effects of water lettuce and poultry manure fertilization rates on relative water content, flowering and fruition rate in pepper cultivars (16 WAS).

Cultivars	Irrigation	Nutrient sources	Treatment (t ha-1)	FLO (days)	FRU (days)	RWC (%)
			Yield component			
Granada	Tap water	Control	0	72.8±2.22c	123.4±2.33c	79.8±0.09d
		NPK	0.1	69.5±2.11d	119.2±2.78d	84.5±0.08c
		Water lettuce	3	66.4±2.43d	115.6±2.44e	85.1±0.11c
			6	62.5±3.21e	112.6±1.22f	87.2±0.07b
			12	60.7±2.67f	110.3±1.66f	89.8±0.14b
		Poultry manure	3	64.7±2.97e	113.5±2.54f	86.3±0.12b
			6	61.4±1.16f	110.3±2.13f	88.1±0.17b
			12	57.9±1.22g	105.7±2.16h	90.4±0.19a
	Tap water + 50mm NaCl	Control	0	76.2±1.34b	129.3±2.54b	75.7±0.0O9e
		NPK	0.1	71.6±2.36c	124.6±2.58c	79.4±0.14d
		Water lettuce	3	70.8±2.44c	120.8±1.44d	80.3±0.12d
			6	68.4±2.12d	117.5±1.12e	82.4±0.11c
			12	66.2±2.54d	115.4±1.76e	84.3±0.21c
		Poultry manure	3	68.1±2.28d	117.2±2.11e	81.5±0.14d
			6	64.2±2.15e	114±2.65e	84.1±0.21c
			12	62.6±2.61e	112.4±2.68f	86.6±0.19b
Nobili	Tap water	Control	0	75.6±2.81b	125.7±2.34c	81.4±0.18d
		NPK	0.1	70.9±3.22c	120.1±1.43d	85.2±0.17c
		Water lettuce	3	70.1±2.71c	119.7±1.86d	85.8±0.09c
			6	66.6±1.88d	115.5±1.65e	87.2±0.06b
			12	63.4±1.11e	111.8±2.43f	90.5±0.11a
		Poultry manure	3	68.4±2.14d	117.5±2.78e	86.7±0.12b
			6	66.5±1.55d	113.6±2.81f	89.2±0.09b
			12	62.6±1.32e	109.8±1.23g	92.1±0.12a
	Tap water + 50mm NaCl	Control	0	80.3±1.58a	129.3±1.23b	76.4±0.14e
		NPK	0.1	76.2±1.72b	127.5±2.11b	80.6±0.21d
		Water lettuce	3	74.3±1.86b	123.5±2.76c	81.7±0.24d
			6	70.6±1.91c	120.4±2.15d	80.9±0.11d
			12	68.±1.48d	118.7±2.27d	83.2±0.08c
		Poultry manure	3	72.7±2.66c	121.3±1.18d	82.5±0.07c
			6	69.2±2.69d	118.5±1.45d	85.8±0.11c
			12	65.5±3.1e	115.4±1.66e	84.6±0.13c
Goliath	Tap water	Control	0	76.7±2.32b	127.9±2.11b	83.5±0.08c
		NPK	0.1	72.1±3.14c	123.3±1.17c	87.2±0.16b
		Water lettuce	3	72.3±2.74c	121.7±1.81d	88±0.18b
			6	70.4±2.82c	117.2±1.67e	89.2±0.12b
			12	68.6±2.77d	114.5±2.09e	91.3±0.21a
		Poultry manure	3	71.1±3.16c	119.3±2.07d	89.9±0.16b
			6	70.7±1.71c	116.3±1.99e	90.1±0.21a
			12	67.5±2.14d	111.5±1.17f	93.8±0.15a
	Tap water + 50mm NaCl	Control	0	81.4±2.91a	133.8±1.23a	79.2±0.22d
		NPK	0.1	76.3±3.21b	128.4±2.03b	83.6±0.18c
		Water lettuce	3	74.3±4.22b	125.5±2.06c	84.1±0.16c
			6	73.4±3.25c	122.6±1.86c	85.2±0.09c
			12	70.2±3.21c	119.4±2.04d	87.6±0.12b
		Poultry manure	3	73.7±3.09c	123.1±2.11c	85.3±0.16c
			6	68.5±2.78d	120.7±3.01d	86.3±0.17b
			12	70.3±2.88c	116.4±3.21e	89.9±0.33b
Two way ANOVA results						
Cultivars (C)				NS	*	*
Salt treatment (S)				*	*	*
Water lettuce (WL)				*	*	*
Poultry manure (PM)				*	**	**
Interaction C x S				*	*	*
Interaction WL x S				*	*	*
Interaction PM x S				*	*	*
Interaction WL x C				*	*	NS
Interaction PM x C				*	*	*