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Full Length Research Paper

Mineral nutrient status, some quality and morphological characteristics changes in peanut (*Arachis hypogaea* L.) cultivars under salt stress

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Peanut (*Arachis hypogaea* L.) is considered to be one of the most important crops which thrive in newly reclaimed sandy soils as a leguminous crop of high nutritive value and a source of edible oil. Our study tested the effects of different salt levels on mineral nutrient partitioning (Na^+, K^+, Mg^{2+}, Ca^{2+}, P and N) and some quality (dry weight and leaf relative water content) and morphological (plant height, number of leaves) characteristics of peanut commercial cultivars. Four peanut cultivars (Mbiah, Ngondo, Pyrieur and Vanda) were used in this experiment. Three concentrations of salt solution including 50, 100 and 200 mM NaCl and the control (Wacquant nutrient solution) were used in irrigation. The pot experiment was arranged in completely randomized design with four replicates. The leaf relative water content (LRWC) provoked by the salinity in nutrient solution decreased from 85.08 to 83.43%, 87.82 to 85.30%, 85.81 to 78.20% and 85.90 to 79.70% in Mbiah, Ngondo, Pyrieur and Vanda cultivars respectively. The results showed that the salt stress reduced significantly ($p<0.05$) the plant height in Pyrieur cultivar from 40.49 to 21.45 cm, the number of leaves from 11.2 to 7.0, the dry weight of roots from 0.15 to 0.11 g $Plant^{-1}$, the dry weight of stems from 0.37 to 0.15 g $Plant^{-1}$ and the dry weight of leaves from 0.46 to 0.19 g $Plant^{-1}$. Similar results were obtained in Vanda cultivar where the supply of nutrient solution with salinity reduced significantly ($p<0.05$) the plant height from 38.26 to 26.30 cm, the number of leaves from 12.5 to 7.5, the dry weight of roots from 0.14 to 0.03 g $Plant^{-1}$, the dry weight of stems from 0.36 to 0.12 g $Plant^{-1}$ and the dry weight oh leaves from 0.46 to 0.19 g $Plant^{-1}$. The results also revealed that K^+, Mg^{2+}, Ca^{2+}, P, N, K^+/Na^+ and Ca^{2+}/Na^+ uptake of peanut plant organs were significantly ($p<0.05$) reduced with increasing salinity in Pyrieur, Vanda and Mbiah except for total N accumulation in plant organs of Mbiah. The plant height, the number of leaves, the dry weight and the mineral nutrient uptake were not significantly ($p>0.05$) reduced under salt stress in Ngondo plant organs except at high salt-treated (200 mM NaCl). The Ngondo cultivar was observed to have relatively higher tolerance on average of all growth parameters and mineral nutrient status than others. This finding suggested that the Ngondo cultivar could be used to highlight the newly salt cultivated sandy soils in arid, semi-arid regions and similar environments across Cameroon.

Key words: *Arachis hypogaea*, growth parameters, mineral nutrient, plant organs, salt stress.

INTRODUCTION

Peanut (*Arachis hypogaea* L.) is one of the more important grain legume in tropical cropping systems in Africa in which it is grown mainly by smallholder farmers (Nyabyenda, 2005). Grain legumes provide large amounts of high quality proteins which contain relatively more of the essential amino acids not supplied by cereals in which the content of lysine and tryptophan are relatively small (Kay, 1979). Peanut is also useful sources of

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fat (34 - 54%) and very important in crop rotation systems as they help in biological nitrogen fixation (Delgado et al., 1994; Nyabyenda, 2005).

Salinity is a very serious constraint to crop plant growth in about 100 countries of the world (Munns, 2002; Sadiq, 2003). It can inhibit plant growth by a range of mechanisms, including low external water potential, ion toxicity and interference with the uptake of nutrients (Munns and Schachtman, 1995; Taffouo et al., 2008, 2009). The degree to which each of these factors affects growth depends on the plant genotype and environmental conditions (Zadeh and Naeini, 2007). According to Munns and Schachtman (1995), in the first phase of a biphasic model of growth response to salinity, the vegetatif growth is reduced by a decrease in a soil water potential due to water stress effect and may be regulated by inhibitory signals from the roots. Plants growing in arid or semi-arid lands, may exhibit more tolerance to salt stress, because of the accumulation of osmo-protectants in their tissues (Munns, 2002; Le Rudulier, 2005; Taffouo, 2005). In the second phase, the concentration of Na^+ and Cl^- increases in plant tissues. In this phase, plants with different abilities to exclude or sequester toxic ions will display different levels of salt tolerance.

Maintaining adequate nutrient elements in the growing media under salinity is a common goal in grain legume production, as it generally increases growth rates. Soil salinity, saline irrigation water and also the heavy use of fertilizers salts can severely restrict plant growth, cause foliage damage and even death of the plants (Taffouo et al., 2010). The influence of salinity and mineral nutrient added to the nurtrient solution, on productivity, photosynthesis and growth has been studied in different plants (Cokuysal et al. , 2006; Hosseini et al., 2007; Mekhaldi et al., 2008; Taffouo et al., 2008, 2010). It stated that high levels of Na^+ inhibits Ca^{2+} and K^+ absorption, which results in a Na^+/K^+ antagonism (Al-karaki, 1997) and net photosynthesis is affected strongly by NaCl conditions, which is related directly to the closure of stomata as well as to low intercellular CO_2 levels (Turan et al., 2007). Saghir et al. (2002) reported that salinity increases Na^+ and Cl^- and decreases K^+, Ca^{2+} and Mg^{2+} in leaves of cotton. The effect of sodium chloride and sodium sulphate salinities on growth and mineral nutrition of peanut (*A. hypogaea* L.) variety TMV-10 has been studied. Chavan et al. (1980) found that NaCl and Na_2SO_4 caused accumulation of Na, P, Fe and Mn in root, stem, leaf and gynophore whereas K uptake was hampered by both salts and Ca uptake was retarded mainly by Na_2SO_4. Nevertheless, nutrient supply is not uniform down the soil profile and crop plants differ in their ability to obtain nutrients from different soil profiles (Genney et al., 2002). Several investigations indicated that salinity affects metabolic processes and induces irreversible physiological disorders (Le Rudulier, 2005; Lachaal, 1998). Identifying potential mechanisms of salt tolerance within plant species is becoming an increasing research priority in several countries in order to efficiently select for tolerant cultivars which could be cultivated in environments with varying salinity. Mekhaldi et al. (2008) indicated that it is important to make call to the ecophysiological approach that it can constitute an alternative for the attenuation of the effect of the soils salinity on the cultivated plant performances. This way should drive in search of tolerant species or varieties of plant that would impose a mastery of the knowledge on the mechanisms of their adaptation to the salinity.

In this article, we propose the results of morphological behavior and mineral nutrient partitioning of a leguminous (*Arachis hypogaea* L.) cultivar subjected to the salinity constraints. The main objective was to evaluate the salt tolerance at vegetative growth stages of some peanut cultivars and identification of salt tolerant ones which could be cultivated in arid, semi-arid and coastal saline soils.

MATERIALS AND METHODS

Plant material, germination and growth conditions

Four peanut cultivars (*Arachis hypogaea* L.) were used in this experiment: Mbiah and Pyrieur were obtained from the Agronomic Institute for Research and Development (IRA, Dschang), Ngondo was collected from the Coastal area of Cameroon and Vanda was originated from Adamaoua region of Cameroon. Seeds with similar size and weight were washed with distilled water. Seeds were then sterilized for 20 min using sodium hypochlorite 3% and rinsed with distilled water 5 times. Sterilized seeds were germinated in Petri dishes at 26±3°C for 5 days. Seedlings with equal sizes were separated in four groups of 15 individuals each. For each group, five seedlings were randomly selected and sowed together in the same pot filled with 1000 g of sand (previously cleaned and rinsed respectively in HCl and distilled water). Pots were kept in laboratory (temperature: 26 ± 3°C, light: 5000 lux for 12 h alternating periods and relative humidity of 51-70%) and supplied every three days with nutrient solution containing 0.4 mM of KNO_3, 0.2 mM of KH_2PO_4, 1.0 mM of Ca_2NO_3 and 0.4 mM of $MgSO_4$ (Wacquant, 1974). The control group of seedlings was fed using Wacquant nutritive solution (pH = 6) without salt (0 mM NaCl). In completely randomized block design, there were three experimental groups supplied daily with salt concentrations of 50, 100 and 200 mM NaCl, respectively (Taffouo et al., 2010), four cultivars and four replicates. The plants were irrigated with the de-ionized water. Five randomly chosen plants from each cultivar and treatment were harvested after 6 weeks culture under salt stress and used for physiological analysis.

Plant measurements

After one week of culture, the plant height was measured every two days in each group of seedlings. Plant samples were harvested after 6 weeks culture under salt stress, leaves, stems and roots were separated and the number of leaves was determined. The tissues (leaves, stems and roots) were dried for 48 h at 85°C (Taffouo et al., 2009). The dry samples were weighted. Leaf Relative Water Content (LRWC) was calculated using the following formula:

$$LRWC = (FW - DW)/ (TW - DW) \times 100$$

Where, FW is leaf fresh weight, TW is the turgid weight measured

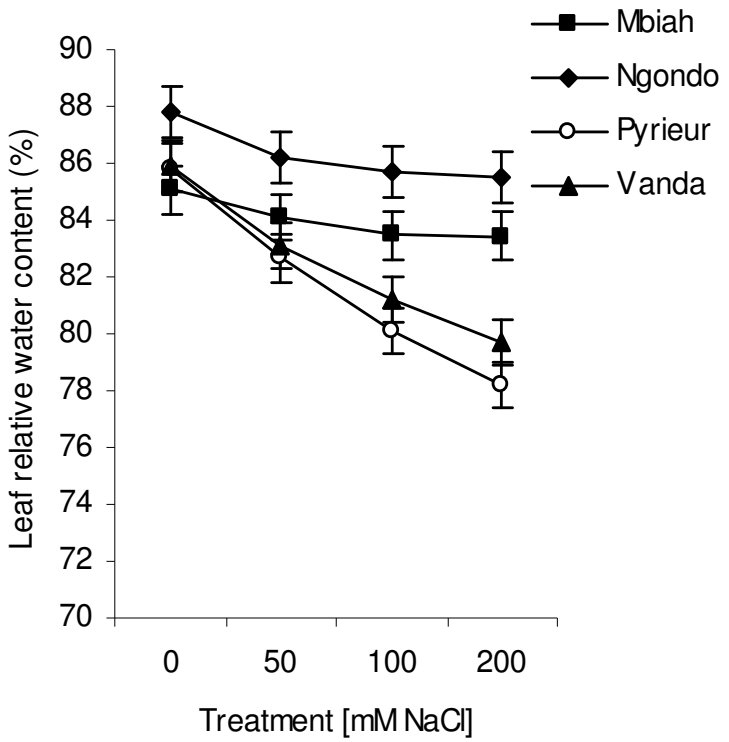

Figure 1. Leaf water relative content (%) in plants of peanut cultivars under 0, 50, 100 and 200 mM NaCl. The bars represent the mean standard error.

after 24h of saturation on deionised water in the dark (Creus et al., 1998) and DW is the dry weight determined after 48 h in an oven at 85°C (Taffouo et al., 2009).

Mineral analysis

The harvested plants were washed with distilled water and then they were dried in an oven for 48 h at 85°C. For the analysis of Na^+ and K^+, five samples each of 0.5 g of roots, stems and leaves of dry materials were thoroughly grinded and homogenized into 20 mL of HCL 1/10 for 24 h. Sodium and potassium were determined through Flame photometer (Jenway) as described by Taffouo et al. (2008). For the determination of the Mg^{2+}, Ca^{2+}, P and N concentrations, five samples each of 0.5 g were placed in a digestion flash where 5 mL of H_2SO_4 was then added and heated in a hot plate at 450°C for 7 min. then, 10 mL of H_2O_2 (50%) was added into the digestion set with a small funnel. The digestion flash was removed from the hot plate using a glove when cool and a clear concentrated solution produced. The solution made up to 100 mL with deionised water. The solution was analyzed using the Auto Analyzer (Technicon II, model 403) (Taffouo, 1994).

Statistical analysis

The pot experiment was arranged in completely randomized design with four salt concentrations and four replicates. Data are presented in term of mean (± standard deviation). Multiple comparisons of several means were set up using analysis of variance (ANOVA) and LSD test. Multiple comparisons of data noted in experimental groups versus those recorded in the single control group were set up using the Dunnett's procedure (SigmaStat software 2.03).

RESULTS

Quality and morphological characteristics changes of peanut under salt stress

Leaf relative water content

The LRWC in the control condition was significantly ($P<0.05$) higher in Ngondo cultivar than Mbiah, Pyrieur and Vanda (Figure 1). After 6 weeks of salt treatments, the LRWC decreased markedly in the leaves of Vanda and Pyrieur than Mbiah and Ngondo. The decrease of the LRWC due to salinity and exposure time was more severe in Vanda than Pyrieur (Figure 1).

Dry weight

Roots and stems dry weight of the Mbiah cultivar was much lower than that of other studied cultivars in the non-saline control plants (Figure 2a). After 6 weeks of salt treatments, the only roots dry weight of salt-treated Vanda plants was significantly lower than that of control plants (Figure 2a) whereas the stems dry weight of Pyrieur and Vanda plants was decreased markedly at all levels of NaCl (Figure 2b). The stems dry weight of Mbiah was much lower at 200 mM NaCl than that of other studied cultivars. In contrast, leaves dry weight of Ngondo

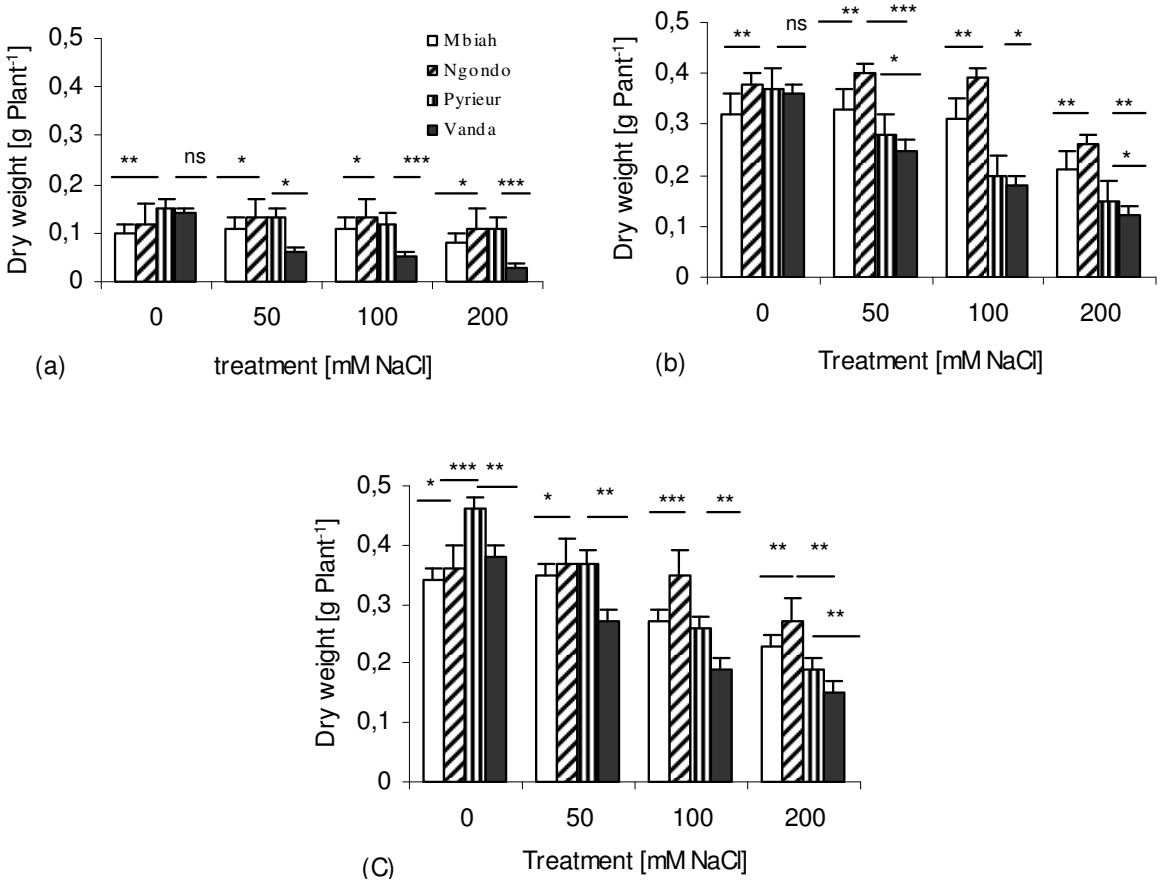

Figure 2. Salt effect on dry weight (g Plant^{-1}) of peanut seedlings organs. (a) Roots; (b) Stems and (c) Leaves. Values are the means of 12 plants. Bars show SE of four independent replications. values headed by * indicate significant difference (* = P < 0.05 ; ** = P < 0.01 ; *** = P< 0.001) and ns no significant difference between treatments

cultivar were much higher than that of other varieties in control plants (Figure 2c). After 6 weeks of salt treatments, leaves dry weight of the Pyrieur and Vanda varieties showed significant decreases with salt concentration. In contrast, after 6 weeks exposure to salinity, Mbiah cultivar indicated lower decrease of leaves dry weight at high salt-treated (100 and 200 mM NaCl) than that of control plants whereas dry weight of leaves of Ngondo plants was decreased significantly at 200 mM NaCl (Figure 2c).

Plant height

After 6 weeks of salinization plant heights of Mbiah and Ngondo varieties were not significantly (P>0.05) reduced with respect to the control plants, except for Mbiah at high salt-treated (200 mM NaCl) (Figures 3a and 3b). Pyrieur and Vanda cultivars showed under salt treatment lower plant height than the control plants (Figures 3c and 3d). The lowest reductions were observed in Pyrieur cultivar.

Number of leaves

High salinity treatment (200 mM NaCl) induced senescence and drying of old leaves in all cultivars. Data recorded indicated that the number of leaves of Mbiah and Ngondo cultivars was less affected by salt treatment than the other two cultivars (Figures 4a and 4b). Treating plants with salinity solution resulted in remarkable decrease of number of leaves in two peanut cultivars (Pyrieur and Vanda) compared with control plants (Figures 4c and 4d).

Mineral nutrient status

Concentrations of mineral elements in plants organs

The concentrations of Na^+ were low in organs of control plants but increased in the all cultivars under salt stress (Table 1). The Na^+ concentrations increased significantly (P<0.05) with increasing salinity in plants organs of all the peanut cultivars. The Na^+ concentrations in roots, stems

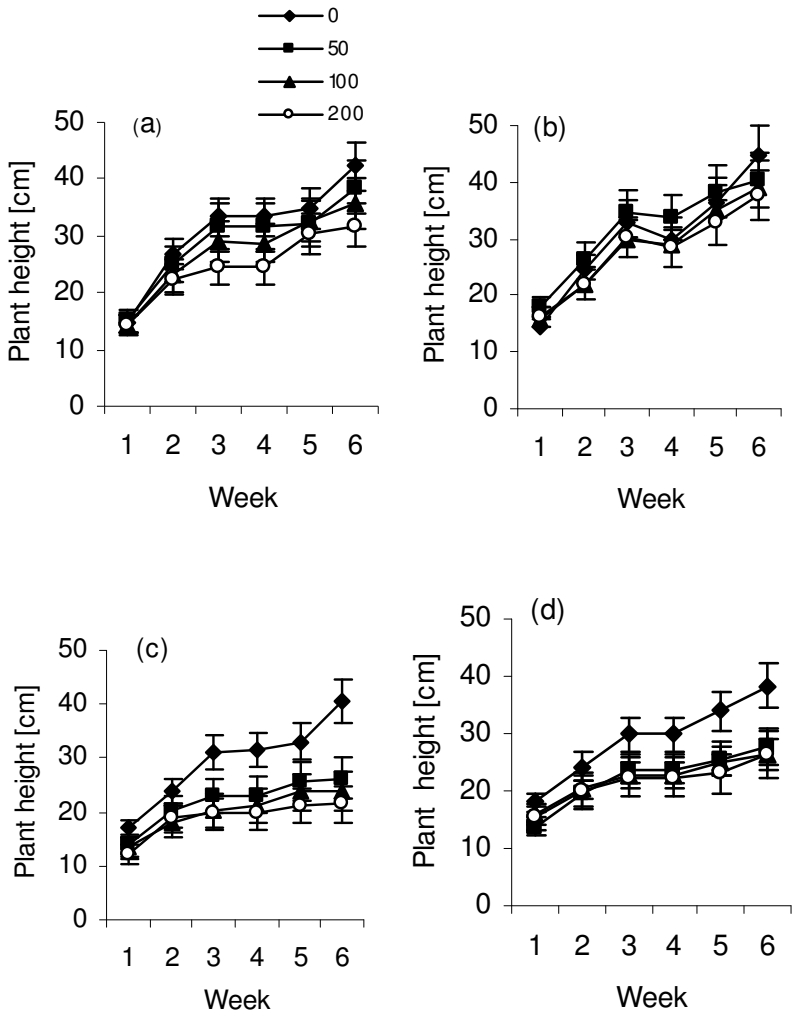

Figure 3. Salt effect on plant height (cm) of peanut cultivars. (a) Mbiah; (b) Ngondo; (c) Pyrieur; (d) Vanda. Values are the means of 12 plants. Bars show SE of four independent replications.

and leaves were lower in Pyrieur and Vanda than Mbiah and Ngondo under salinity.

The K^+ concentrations were markedly higher in Ngondo plants organs than Mbiah, Pyrieur and Vanda varieties in the control condition (Table 1). A significant decrease was observed in the concentration of K^+ in roots, stems and leaves and K^+/Na^+ selectivity ratio in all the cultivars under salt stress. Mg^{2+}, Ca^{2+} and P concentrations decreased significantly in roots, stems and leaves of all cultivars under salinity except for Ngondo plant organs at salt-treated (50 and 100 mM NaCl) (Tables 1 and 2). Salt treatments increased significantly ($P<0.05$) total nitrogen concentrations in roots, stems and leaves of Mbiah and Ngondo cultivars. In contrast, the significant decrease was observed in total N concentrations in roots, stems and leaves of Pyrieur and Vanda cultivars under salt treatments. Similar results were obtained with Ca^{2+}/Na^+ selectivity ratio in all cultivars under salt stress (Table 2).

DISCUSSION

Quality and morphological characteristics changes of peanut under salt stress

The leaf relative water content (LRWC) provoked by the salinity in nutrient solution decreased in all the peanut cultivars. According 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. These results are similar with found by Taffouo et al. (2010) studying the salt stress effects on water status of *Vigna subterranea*, in which the addition of NaCl resulted in a decrease of water content partitioning of black seed coat and light red seed coat landraces. The salt stress simulated in this experiment cause as direct consequence changes in LRWC. In fact during transpire-

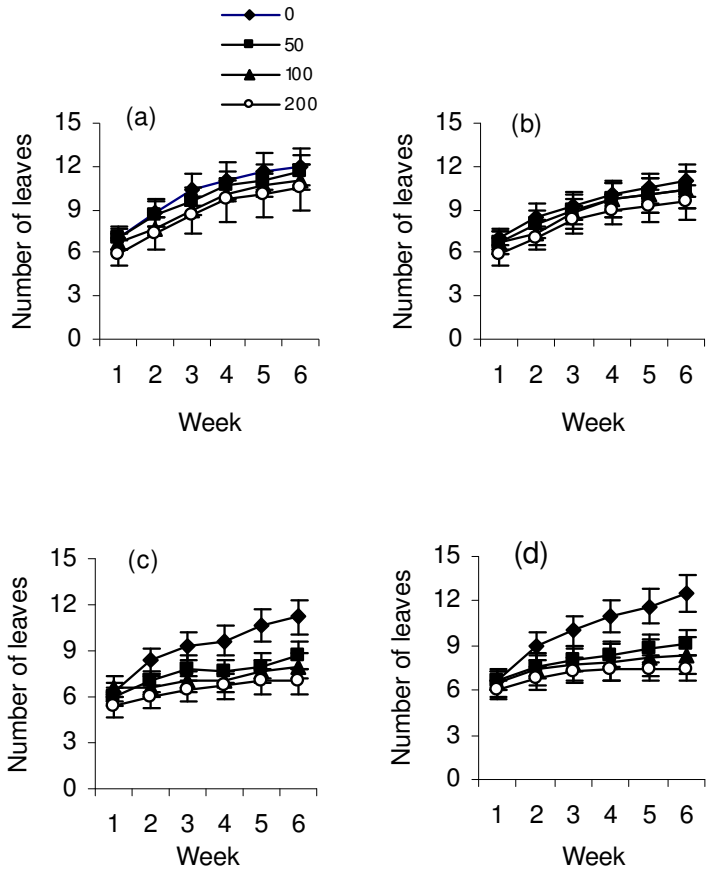

Figure 4. Salt effect on number of leaves of peanut cultivars. (a) Mbiah; (b) Ngondo; (c) Pyrieur; (d) Vanda. Values are the means of 12 plants. Bars show SE of four independent replications.

tion process and photosynthesis the water loss through the stomata and the assimilation rate is strongly affected. Afterwards the stomata conductance decrease for reduce the water loss to the atmosphere (Verslues et al., 2006; Lobato et al., 2008). The plant height, the number of leaves and the dry weight of roots, stems and leaves of the Pyrieur and Vanda cultivars showed significant decreases with salt concentration compared at those of Mbiah and Ngondo cultivars after 6 weeks of salt treatments. These results demonstrate that Pyrieur and Vanda cultivars, in common with certain other plant leguminous (e.g. beans), is highly sensitive to salt with severe effects even at 50 mM NaCl (Levitt, 1980). For these plants species, salinity may reduce the growth by upsetting water and nutritional balance of plant (Chavan et al., 1980; Munns and Schachtman, 1995; Taffouo et al., 2008, 2009) and loss of photosynthesis capacity (Rajest et al., 1998; Alam et al., 2004). The Ngondo cultivar was observed to have relatively higher tolerance on average of all growth parameters than others. Similar observations for plant growth were reported in *Ceriops roxburghiana*, *Phaseolus adenanthus*, *Lagenaria siceraria* and *Vigna subterranea* var. white seed coat described as salt-tolerant plant species (Rajest et al., 1998; Taffouo et al., 2008, 2010). There are a great number of plant species which are regarded as salt tolerant, the most competitive being those that are able to become established, grow to maturity and survive until they are able to reproduce (Turan et al., 2007).

Mineral nutrient status

In the experiment, salt stress, induced by increasing NaCl in the soil solution, resulted in an increase in Na^+ concentrations in plant organs of all the peanut cultivars. There was an overwhelming amount of evidence to indicate that NaCl-induced salinity increased Na^+ and Cl^- uptake by plants (Saghir et al., 2002; Hosseini et al., 2007; Turan et al., 2007; Zadeh and Naeini, 2007; Taffouo et al., 2008, 2010). The present study showed that K^+, Mg^{2+}, Ca^{2+}, P, K^+/Na^+ and Ca^{2+}/Na^+ uptake of peanut plant organs were significantly reduced with increasing salinity except for Mg^{2+}, $Ca^{2+}$and P accumu lation in plant organs of Ngondo cultivar at salt-treated (50 and 100 mM NaCl). Similar observations were

Table 1. Distribution of Na^+, K^+, Mg^{2+} concentrations (g Kg^{-1}) and K^+/Na^+ ratio among peanut seedlings organs after 6 weeks culture under salt stress on Wacquant medium (control), media with 50, 100 and 200 mM NaCl. Values are the means of 5 repetitions ± SE.

Cultivars	NaCl Treatments (mM)	Na^+			K^+			Mg^{2+}			K^+/Na^+
		Roots	stems	leaves	Roots	stems	leaves	Roots	stems	leaves	
Mbiah	0	1.2±0.1b	1.2±0.2b	2.3±0.2c	20.3±0.3a	30.2±0.4a	34.7±0.2a	32.5±0.1a	15.5±0.2a	43.4±0.3a	15.08a
	50	4.3±0.1ab	5.1±0.1ab	9.5±0.3bc	14.7±0.1b	22.1±0.2ab	25.9±0.4b	31.3±0.3a	15.2±0.3a	42.2±0.1a	2.73b
	100	7.1±0.2a	8.7±0.3a	15.3±0.2b	13.8±0.2b	20.2±0.3ab	24.2±0.1b	29.4±0.2a	11.9±0.3b	33.7±0.2b	1.58bc
	200	9.5±0.2a	10.3±0.2a	19.4±0.4a	12.8±0.3b	15.8±0.2b	23.9±0.1b	15.9±0.1b	10.5±0.2b	31.8±0.2b	1.23c
Ngondo	0	1.7±0.1b	1.4±0.1b	2.2±0.1c	21.6±0.5a	32.5±0.3a	37.4±0.3a	29.3±0.2a	13.3±0.1a	42.1±0.1a	16.09a
	50	5.5±0.1ab	6.7±0.2ab	11.2±0.3bc	14.4±0.2b	23.7±0.3b	28.5±0.1b	26.8±0.1a	12.5±0.1a	38.6±0.3a	2.54b
	100	8.5±0.2a	10.1±0.1a	16.3±0.2b	13.2±0.3b	18.8±0.2bc	27.3±0.3b	25.9±0.3a	11.6±0.2a	36.7±0.3a	1.67bc
	200	10.2±0.3a	11.2±0.2a	21.6±0.3a	11.9±0.1b	16.5±0.3c	24.8±0.2c	14.2±0.2b	6.6±0.1b	30.1±0.2b	1.15c
Pyrieur	0	1.8±0.1c	1.2±0.1b	1.3±0.1b	18.9±0.2a	27.6±0.2a	32.9±0.3a	30.1±0.2a	15.0±0.1a	40.9±0.2a	25.30a
	50	7.0±0.2bc	5.5±0.1ab	5.1±0.1a	13.8±0.4b	17.1±0.2b	20.7±0.3b	17.9±0.3b	10.1±0.2b	28.9±0.2b	4.05b
	100	11.2±0.2b	7.1±0.2a	5.5±0.1a	11.3±0.1b	12.9±0.1bc	14.1±0.1bc	14.3±0.2b	7.2±0.1b	20.6±0.1bc	2.56bc
	200	17.2±0.3a	9.3±0.2a	7.0±0.1a	10.2±0.2c	7.3±0.1c	9.6±0.4c	8.4±0.1c	7.0±0.1b	13.3±0.1c	1.37c
Vanda	0	1.3±0.1c	1.1±0.1b	1.9±0.1b	18.8±0.4a	24.1±0.1a	33.1±0.4a	33.0±0.1a	18.1±0.2a	45.8±0.3a	17.42a
	50	6.5±0.2bc	4.2±0.1ab	2.2±0.1b	13.3±0.3b	15.8±0.4b	19.4±0.2b	16.2±0.2b	13.6±0.1b	32.4±0.2b	8.81b
	100	9.3±0.2b	8.1±0.1a	5.9±0.1a	12.2±0.3b	14.4±0.2b	12.9±0.4c	14.1±0.2b	8.9±0. 2c	23.8±0.3bc	2.19bc
	200	14.1±0.3a	9.6±0.2a	7.1±0.1a	10.1±0.2b	9.2±0.1c	10.1±0.2c	10.3±0.1c	7.1±0.2c	15.8±0.3c	1.42c

Means±SE (n =5) with different letter are significantly different at $p<0.05$ by LSD test within variety

reported by Chavan et al. (1980) in *A. hypogea* L. variety TMV-10 where the inorganic analysis revealed that NaCl and Na_2SO_4 caused accumulation of Na^+ and P in root, stem, leaf and gynophore whereas the uptake of K was hampered by both salts. In contrast, the difference between ours results and those obtained by Chavan et al. (1980) was that Ca^{2+} uptake was retarded in saline conditions mainly by two peanut sensitive cultivars (Pyrieur and Vanda) while in *A. hypogea* L. variety TMV-10, the NaCl supply did not hampered Ca^{2+} uptake. It is stated that high levels of Na^+ inhibits Ca^{2+} and K^+ absorption, which results in a Na^+/K^+ antagonism [(Al-karaki, 1997). Salt stress is known to significantly reduce K^+ uptake related with reduce intracellular K^+ concentration especially in the vacuolar pool of barley leaves (Cuin et al., 2003). Saghir et al. (2002) reported that salinity reduces uptake of Mg^{2+} in leaves of cotton. Similarly, in *Salicornea*, salt levels decreased dry matter production and the uptake of Mg^{2+} (Levitt, 1980). In other cases, a reduction in plant P concentration by salt levels may result from the reduced of P in the growing media solution due to the high ionic strength of the media.

Results are in agreement with data presented by Al-karaki (1997) who have stated that phosphate availability is reduced in saline conditions not only because of ionic strength effects that reduce the activity of P but also because of P concentrations in growing media solution are tightly controlled by sorption processes and by low

Table 2. Distribution of Ca^{2+}, P and total N concentrations (g Kg^{-1}) and Ca^{2+}/Na^{+} ratio among peanut seedlings organs after 6 weeks culture under salt stress on Wacquant medium (control), media with 50, 100 and 200 mM NaCl. Values are the means of 5 repetitions ± SE.

Cultivars	NaCl Treatments (mM)	Ca^{2+}			P			N			Ca^{2+}/Na^{+}
		Roots	Stems	Leaves	Roots	Stems	Leaves	Roots	Stems	Leaves	
Mbiah	0	26.1±0.2a	19.3±0.2a	62.1±0.4a	7.8±0.2a	4.5±0.2a	17.5±0.3a	10.5±0.3a	15.2±0.4b	24.2±0.1c	27.00a
	50	19.1±0.1b	16.2±0.1a	57.1±.0.3a	7.3±0.2a	3.7±0.1a	14.7±0.2a	10.3±0.1a	17.1±0.2b	36.2±0.3b	6.01b
	100	17.2±03b	15.1±0.2ab	45.6±0.2ab	4.0±0.1b	2.5±0.1b	10.2±0.1b	10.2±0.2a	17.8±0.3b	51.1±0.4ab	2.98c
	200	16.2±0.4b	11.2±0.2b	39.3±0.3b	3.7±0.1b	2.3±0.1b	9.0±0.1b	10.1±0.2a	19.4±0.2a	58.2±0.5a	2.03c
Ngondo	0	24.2±0.1a	18.2±0.1a	51.4±0.5a	8.5±0.3a	4.9±0.1a	14.7±0.2a	12.2±0.2a	12.5±0.4b	26.4±0.3c	23.37a
	50	17.2±0.2b	16.9±0.4a	48.2±0.4a	5.8±0.1b	2.6±0.2b	14.4±0.2a	13.1±0.3a	18.1±0.2a	31.2±0.3b	4.30b
	100	16.3±0.2b	16.1±0.1a	47.9±0.3a	4.7±0.2b	2.3±0.1b	13.8±0.2a	12.1±0.3a	18.8±0.3a	51.2±0.3ab	2.93c
	200	15.8±0.2b	15.2±0.1a	38.2±0.2b	4.3±0.2b	2.1±0.2b	10.4±0.2b	11.2±0.2a	20.4±0.2a	57.2±0.4a	1.77c
Pyrieur	0	24.3±0.3a	15.3±0.3a	53.2±0.3a	9.5±0.2a	5.8±0.1a	15.6±0.1a	12.2±0.2	17.3±0.2a	27.6±0.2a	40.92a
	50	14.1±0.1b	12.1±0.3a	35.3±0.3ab	6.9±0.2b	2.5±0.1ab	11.6±0.1ab	7.1±0.2	12.2±0.1b	17.5±0.2ab	6.92b
	100	12.2±0.2b	10.2±0.2b	29.2±0.2b	3.7±0.1c	2.2±0.1an	10.3±0.2ab	5.9±0.2	10.1±0.2b	12.4±0.2b	5.31b
	200	10.1±0.4b	9.2±0.1b	22.3±0.3c	3.1±0.1c	1.4±0.1c	5.7±0.1b	5.6±0.1	7.7±0.1c	9.0±0.1c	3.19c
Vanda	0	25.2±0.4a	17.2±0.3a	56.9±0.3a	7.6±0.1a	49±0.2a	16.1±0.3a	11.2±0.3	18.2±0.3a	25.1±0.3a	29.94a
	50	15.1±0.4ab	12.5±0.2b	33.9±0.2ab	5.5±0.3ab	2.1±0.1b	11.4±0.1ab	6.9±0.1	14.2±0.2ab	18.3±0.1ab	15.40b
	100	10.5±0.1b	12.2±0.1b	22.4±0.2b	3.3±0.1b	2.1±0.2b	8.2±0.1b	5.4±0.1	11.4±0.1b	13.3±1.1b	3.80c
	200	9.1±0.1b	8.0±0.2c	17.4±0.2c	2.5±0.1b	1.3±0.1c	7.1±0.1b	4.8±0.1	7.2±0.1c	10.1±0.1c	2.45c

Means±SE (n =5) with different letter are significantly different at $p<0.05$ by LSD test within variety

solubility of Ca-P minerals. Experiment evidence shows that N concentrations increased in plant organs of Mbiah and Ngondo cultivars under salt stress. Cokuysal et al. (2006) reported that the assimilation of N was not significantly affected by salinity in *Ficus benjamina*, salt tolerant species. Le Rudulier (2005) suggested that NH_4^+ supplied plants are more susceptible to salinity stress due to the fact that the assimilation of NH_4^+ taken up from the medium is curtailed under salinity since most available energy is required for osmoregulation.

Conclusion

Differences in LRWC, growth and mineral nutrient to salt stress response among peanut cultivars exist. The concentrations of K^+, Mg^{2+}, Ca^{2+}, P, K^+/Na^+ and Ca^{2+}/Na^+ and growth parameters of roots, stems and leaves were significantly reduced with increasing salinity in Pyrieur and Vanda cultivars. Pyrieur and Vanda cultivars were highly sensitive to salt with severe effects at 50 mM whereas in moderately salt-tolerant cultivar (Mbiah) the growth parameters were significantly reduced at 100 mM. The Ngondo cultivar was observed to have relatively higher tolerance on average of all growth parameters than others. It could be used to highlight the newly salt cultivated sandy soils in arid, semi-arid regions and similar environments across Cameroon.

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