J. Agric. Sci. Mansoura Univ., 29(9): 5159 - 5179, 2004

AMELIORATING THE INJURIOUS EFFECTS OF SALINITY ON BALADI COWPEA, USING PHOSPHATE, NITRATE AND CITRATE IONS.

Fathy, El-S. L. El-S.
Vegt. Dept., Hort. Res. Inst., Giza, Cairo.

ABSTRACT

Experiments were conducted at El-Bramoon Exp. Farm, Hort. Res. Inst., during 2001 and 2002 summer season. In order to study the effect of NaCl salinities (0, 4000 and 8000 ppm) and the applied ameliorative ions, phosphate (phosphoric acid form, 0.35 ml/L), nitrate (nitric acid form, 0.35 ml/L) and citrate (citric acid form, 5 g/L) in irrigation water and their interaction on the ionic, physiological and agronomical performances of Baladi cowpea. Each three weekly successive salt treatments were followed by one ameliorative ion treatment up to nine and three applications respectively during the season. Results could be summarized as follows:-

1. Effects of salinity: As the intensity of NaCl salt stress increased, plant height, dry matter / plant (g), number of flowers and pods / plant, pods and seeds yield / plant (g) were significantly decreased in the two seasons. The whole plant dry weight decreased by 20.7 and 31.0% (mean of two seasons relative to control) at moderate and high (4000 and 8000 ppm NaCl), respectively. Also, pods and seeds yield were decreased by 24.8 and 25.6% and 46.8 and 47.0%, respectively.
2. Effects of the ameliorative ions: Applying phosphate followed by nitrate and citrate were significantly improved growth and yield as they greatly reduced the accumulation of salt ions and improved useful nutrients, protein and carbohydrates content. Also, increased the whole plant dry weight by 51.9, 41.4 and 25.7%, pods and seeds yield by 46.5 and 47.7%; 31.0 and 32.4% and 22.3 and 11.4%, respectively relative to the control.
3. Effect of interaction: The presence of phosphate followed by nitrate and citrate ions in growth substrate was greatly reduced the adverse effects of moderate and to some extent of higher salinity. Phosphate was the most effective one. At moderate salinity, total dry weight reduced by 30.1%, pods and seeds yield by 30.7 and 32.8%, after phosphate application those were fully restored to the normal values of control or above, they were increased by 10.0, 4.3 and 4.9%, respectively. At higher salinity, those were reduced by 43.0, 54.2 and 52.0%, respectively, phosphate alleviated the declines to be only 3.9, 25.0 and 26.5%, respectively.
4. A positive correlation between pod and seed yields vs. total dry weight, total carbohydrates, crude protein, N, P, K, Ca, K/Na and Ca/Na values was observed. On contrary, negative correlation was found with Na and Cl content. Correlation values confirmed the essentiality of K/Na, Ca/Na, protein, Na and Cl values and contents as indicators for salt adaptation.
5. Baladi cowpea considered as relatively less salt sensitive (moderate salinity)and moderately sensitive (higher salinity), they maintained no extreme physiological disturbances parallel with no agronomical extreme alterations as NaCl levels was double folded.
6. It could be concluded, with adding phosphate (phosphoric acid, 0.35 ml/L) through three applications in irrigation water during the growing season of cowpea to obtain normal yield at moderate (4000 ppm NaCl) and less reduced yield at higher (8000 ppm NaCl) salinities. Also, nitric and citric were of beneficial effects.

INTRODUCTION

Salinity remains one of the most serious problem influencing the productivity of agricultural system around the world. Under Egyptian conditions, salinity of water and soil became the most serious factor contributes to the considerable reductions in productivity of many crops.

Cowpea is grown under wide range of environments, greatly prevails in arid and semi arid regions, as dry land crops, also greatly grown in Egypt as an important desirable protein rich food. It was reported that it have good tolerance to both heat and drought (Turk *et al.*, 1980).

Greenway and Munns (1980) reported that most vegetables are glycophytes sensitive to higher salinities. Mass and Hoffman (1977) classified cowpea as moderately salt sensitive crop with threshold value of 1.2 dsm^{-1} and yield reduction slope of 14% for each 1 EC raise.

Glycophytes including cowpea, at relatively low salinities excludes salt ions, restricts their translocation into shoots, then suffering from osmotic effects (turgor declines) more than specific toxic effects. To counteracting such effects, they adjusted osmotically by synthesizing compatible organic osmolytes (sugars, organic and amino acids and etc.) at the expense of carbohydrates and energy pools depletion and expenditure from growth and yield activities.

At higher salinities, $PO^{\equiv}_4$ uptake and content found to be greatly reduced (Sharpely *et al.*, 1992), due to the competitive reaction of Cl^- x $HPO^{=}_4$ (Grattan and Grieve, 1999). Also, they stated that salinity cause a physiological inactivation of PO_4 and increase its internal metabolic requirements.

It was known that higher salinity induce low energy case, inactivate the ATP dependent ion transporter H-ATP-ase system, impair membrane integrity and selectivity (low K/Na), sharp increase in Na^+ and Cl^- uptake (Nieman and Clark, 1976; Drew and Lauchli, 1985; and Montero *et al.*, 1998). Also, induce extreme ratios of Na^+/K^+, Na^+/Ca^{++}, Cl^-/NO^-_3 or $H_2PO^-_4$ (Kafkafi *et al.*, 1982; Grattan and Grieve, 1994 & 1999).

As a result, the stressed plants became severely susceptible to osmotic / turgor effects, specific salt ions toxic effects, nutritional imbalances and disorders and energy lack. Thereby impaired chlorophyll, carbohydrate and protein metabolism, in turn serious growth and yield decline with salinity (Tawfik *et al.*, 1977; Coll, 1980; West and Francois, 1982; Helaly *et al.*, 1984; El-Saied *et al.*, 1988; Mahmoud *et al.*, 1988 a&b; Motero *et al.*, 1998; Richter *et al.*, 1999 and Maiti *et al.*, 2002).

Some treatments were suggested to be applied into salt stressed cowpea, such as citrate, phosphate and nitrate ions due to their anti salinity beneficial effects. Adding phosphate hindered Cl^- uptake, improved energy and membrane status, improved growth and yield (Nieman and Clark, 1976 and Grattan and Grieve, 1999).

Nitrate, restricted Cl^- uptake and accumulation, reduced its toxicity, increased cations uptake (K and Ca), in turn, reduced Na uptake, improved growth and yield (Kafkafi *et al.*, 1992 and Grattan and Grieve, 1999).

Citrate suggested effects and roles as organic osmolytes, protective agent for sensitive enzymes and membranes, energy related and anti-oxidantal compound (Lascaris and Deacon, 1991; Mansour *et al.*, 1998; Hasegawa and Bressan, 2000 and Fathy *et al.*, 2003).

Present work was conducted to study the effect of salinities on the morphological and agronomical performances of cowpea, explained those by the physiological one. As well as to improve such performances by applying phosphate, nitrate and citrate ions with irrigation water as an stress ameliorative / protective technique.

MATERIALS AND METHODS

Present work was designed at El-Bramoon Exp. Station, El-Dakahlia Governorate, Hort. Res. Inst., Egypt, during summer seasons of 2001 and 2002. In order to study the effect of different salinity levels (0, 4000 and 8000 ppm NaCl) in irrigation water and the ameliorative effect of phosphate, nitrate and citrate ions and their interaction on different performances of cowpea Baladi cv.

Experimental procedure and cultural conditions:

Cowpea seeds were sown on 1 April in polyethylene bags 25 cm in diameter, filled with clay and sand in 1:1 ratio. Plants were thinned to one plant per each pot (four true leaves stage). Plants were initially irrigated only with tap water during the first month to ensure best establishment. bags were arranged in factorial experiment (3 x 3), randomized complete block design. Each treatment contained 13 bags and replicated 3 times.

One month later, (1 May) plants were frequently irrigated with salinized water, three successive applications (one/week) up to nine applications. Each 3 successive salt applications were followed by one ameliorative ions treatment up to three applications, during the whole season. Irrigation with salt or ameliorative ions was amounted to 0.5 L/plant, increased to 1 L/plant with time. In some cases all bags were irrigated with tap water as control plants required.

Salinity treatments:

Those were represented factor (A). Salinized water was prepared by adding commercial NaCl in tap water. Salt treatments were initiated at increments of around 1000 and 2000 ppm NaCl, respectively in the first four applications to reach final concentrations of 4000 and 8000 ppm concentrations.

The ameliorative ions treatments:

These represented factor (B). Control (irrigated with tap water), phosphate (H_3PO_4 form, 0.35 ml/L), nitrate (HNO_3 form, 0.35 ml/L), and citrate (citric acid form, 5 gm/L). All plants were fertilized with 2.5 g/bag (20-20-20, NPK) (before sowing) and 5 g/bag during fruiting stage.

Experimental parameters:

Growth and dry matter partitioning:

After all treatments were completed, 9 plants from each treatment (3 from each replication) were carefully taken out with their roots. Plant height (cm) was measured, then plants were cut into leaves, stems and roots, washed with tap and distilled water, oven dried (70°C / 72 hr). Dry weight of different plant parts and of the whole plant were determined.

mineral nutrients and salt ions content:

The dried material of leaves used for analysis of N, P, K, Ca and Mg as well as Na and Cl. Na and K were analyzed using flame emission spectrophotometery according to (Horneck and Hanson, 1998), Ca and Mg were determined by atomic absorption technique. N and P were analyzed according to Horneck and Miller (1998) and Cotton (1954), respectively. Cl was determined according to Page *et al.* (1982).

Physiological indicator parameters:

Ratio of K / Na and Ca/Na were calculated from K, Ca and Na content of leaves as a reliable physiological indicators for K and Ca selectively vs. Na ions, as discriminative indicator / mechanism for salt adaptation (Navarro *et al.*, 1999).

In the same dried samples, total carbohydrate was determined colormetrically according to Michel *et al.* (1956). Crude protein was calculated according to AOAC (1990). All as an biochemical adaptive functions underlying salinity stress withstanding (Hasegawa and Bressan, 2000).

Pods and seeds yield:

Number of flowers and pods were recorded all over the season from 15 plants / treatment. Pod yield (fresh yield), either in number or weight was determined from 15 plants of each treatment (5 of each replicate) all over the harvesting season. Seed yield (dry yield) was determined from other 15 plants of each treatment. Harvesting for dry seeds was started as 25% of pods were in known suitable stage (turn yellow and started to dry), those were taken and allowed to be completely dried, then seeds were weighted.

Pod and seed yields subsequently calculated in term of yield (g) per plant based on number of the harvested plants.

Correlative studies:

Pods and seed yields were statistically correlated vs. some important traits to be identified the most useful ones interrelated with yield capacities under present conditions. All data were statistically analysis based on ANOVA. Differences between means were statistically measured using Duncan Multiple Range test.

RESULTS AND DISCUSSION

Growth and dry matter partitioning:
Effect of salinity:

It was obvious that plant height and the accumulation of dry matter into leaves, stems, roots and the whole plant, all were significantly decreased with salinity in two seasons (Table 1).

Table 1. Effect of salinity on growth and dry matter partitioning of cowpea during two seasons.

NaCl (ppm)	Plant height (cm)	Stem DW (g/plant)	leaves DW (g/plant)	roots DW (g/plant)	Total DW (g/plant)
			2001		
0	69.2 a	29.8 a	37.2 a	4.4 a	71.4 a
4000	45.9 b	19.3 b	33.3 b	3.3 b	56.0 b
8000	39.0 c	16.1 c	30.2 c	2.8 c	49.1 c
			2002		
0	76.9 a	29.8 a	37.5 a	4.3 a	71.6 a
4000	56.6 b	20.1 b	34.3 b	3.0 b	57.4 b
8000	48.0 c	16.4 c	30.3 c	2.9 b	49.6 c

Means followed by the same letter(s) within each column do not significantly differ using Duncan's Multiple Range Test.

It could be noticed that leaves showed the least salt sensitivity followed by roots and stems. The whole plant dry weight reduced by 20.7 and 31.0% (means of two seasons) at 4000 and 8000 ppm NaCl salinities, respectively relative to non stressed plant.

Similar growth reduction due to salinities were also reported by Col (1980), West and Francois (1982), Helaly *et al.* (1984), El-Saied *et al.* (1988), Mahmoud *et al.* (1988 a&b), Montero *et al.* (1988), Richter *et al.* (1999), Maiti *et al.* (2002). Some fabaceaes displayed less salt sensitivity such as chickpea (Richter *et al.*, 1999), cheno cowpea and lim bean (Mahmoud *et al.*, 1988a).

Herein, such growth declines with salinity could be due to that low K/Na and Ca/Na values, shifting the uptake ratio in favour of the harmful (Na^+) at the expense of the useful K^+ and Ca^{++} ones.

Decreasing N, Mg and crude protein content, increasing Na^+ and Cl^- content (Tables 4 and 7). Thereby, the stressed plants may became susceptible to the specific Na^+ and Cl^- toxic effect as well as ion imbalances and nutritional disorders (Champagnol, 1979; Kafkafi *et al.*, 1982; drew and Lauchli, 1985; Martinez and Cerda, 1989; Savvas and Lenz, 1996 and Grattan and Grieve, 1994 & 1999).

Effect of interaction:

The data of Table 6 indicated that presence of the ameliorative ions was greatly improved the useful nutrients content of the salt stressed cowpea, those which considerably reduced by salinities. In contrary, the accumulation of Na^{+} and Cl^{-} salt ions tended to be reduced in presence of the ameliorative treatments in two seasons. Useful nutrients (N, P, K, Ca and Mg) were fully restored to values similar to those of non-stressed control at different salinities as affected by phosphate, nitrate and citrate ions.

Also, it was obvious that their effect against the excessive accumulation of salt ions was more pronounced at moderate salinity than higher one. They were more effective in reducing Na accumulation than Cl. The most effective treatment in counteracting the ionic and mineral case during the stress was phosphate > nitrate > citrate in two seasons.

Table 6. Effect of interaction on mineral and ionic concentration in cowpea leaves during two seasons.

NaCl ppm	Amelior. ion	N (%)	P (%)	K (%)	Ca (%)	Mg (%)	Na (%)	Cl (%)
				2001				
0	Control	2.0 def	0.543ef	2.0 f	3.0 c	1.8 bc	0.55 ef	1.8 f
	Nitrate	3.2 a	0.590def	2.2cde	3.7 b	2.0 ab	0.42 fg	1.1 g
	Phos.	2.6 b	0.816 b	2.5 a	4.0 b	2.3 a	0.35 g	1.4 fg
	Citrate	2.4 bc	0.696 c	2.1def	3.7 b	2.3 a	0.52efg	1.1 g
4000	Control	1.8 f	0.336 g	1.6 g	2.1 d	1.7 bc	1.7 b	9.5 b
	Nitrate	2.4 bc	0.613de	2.1def	4.0 b	2.0 ab	0.63 de	5.5 e
	Phos.	2.2cde	0.900 a	2.4 ab	4.9 a	1.4 c	0.54 ef	6.9 d
	Citrate	2.0 def	0.523 f	2.0 ef	3.8 b	0.90 d	0.79 d	7.6 cd
8000	Control	1.5 g	0.353 g	1.5 g	1.3 e	0.76 d	2.2 a	10.3 a
	Nitrate	2.2 cd	0.660 cd	2.3bcd	4.9 a	1.4 c	1.1 c	7.5 cd
	Phos.	2.1 def	0.803 b	2.4abc	4.8 a	1.6 bc	1.0 c	7.4 cd
	Citrate	1.9 ef	0.583def	2.1def	3.6 b	1.8 bc	1.1 c	7.7 c
				2002				
0	Control	2.4 bc	0.53 e	2.1 c	3.3 e	1.9 bc	0.43 e	1.9 f
	Nitrate	3.0 a	0.61 de	2.4 a	4.0cde	2.0 b	0.35 ef	1.0 g
	Phos.	2.6 b	0.78 b	2.1 bc	4.5bcd	2.2 a	0.27 f	1.3 g
	Citrate	2.5 b	0.67 cd	2.2abc	4.6abcd	2.3 a	0.45 e	1.1 g
4000	Control	1.7 f	0.40 f	1.6 d	2.2 f	1.7 cd	1.8 b	8.2 b
	Nitrate	2.5 bc	0.67 cd	2.2abc	4.3bcd	1.8bcd	0.62 d	5.5 e
	Phos.	2.1 d	0.85 a	2.4 ab	5.4 a	1.7 cd	0.63 d	6.0 e
	Citrate	2.1 d	0.60 de	2.2abc	3.7 de	0.93 f	0.73 d	7.3 cd
8000	Control	1.6 g	0.26 g	1.4 d	1.1 g	0.80 f	2.4 a	10.7 a
	Nitrate	2.3 cd	0.59 e	2.2abc	5.3 ab	1.4 e	1.1 c	7.1 d
	Phos.	1.9 e	0.75 bc	2.2abc	4.8abc	1.7 cd	1.0 c	7.4 cd
	Citrate	1.8 ef	0.54 e	2.2abc	3.9cde	1.6 de	1.1 c	7.7 bc

Means followed by the same letter(s) within each column do not significantly differ using Duncan's Multiple Range Test.

Physiological and biochemical parameters:

Effect of salinity:

Data in Table 7 illustrated values of K/Na and Ca/Na as indicators for membrane selectively of K and Ca vs. Na ions and also as discriminative *physiological indicator for salt tolerability or sensitivity (adaptive function)* (Drew and Lauchli, 1985; Garttan and Grieve, 1999 and Navarro *et al.*, 1999), carbohydrate and protein content as indicator for the metabolic machinery case and for their adaptive osmoregullatory and protective functions (Helaly *et al.*, 1984; Pasternak, 1987 and Hasegawa and Bressan, 2000).

It was observed that K/Na and Ca/Na ratios were significantly decreased with salinity, this indicated that with salinity, membrane selectively was impaired and altered to be accumulate more Na than K and Ca. In turn, more metabolic disturbances, ionic imbalances, thereby probably more salt associated harmful effects.

Table 7. Effect of salinity on the physiological and biochemical parameters of cowpea during two seasons.

NaCl (ppm)	K / Na	Ca/Na	Total carbohydrate (mg/g DW)	Crude protein (mg/g DW)
		2001		
0	5.1 a	8.4 a	539.9 b	16.4 a
4000	2.9 b	5.1 b	593.1 a	13.3 b
8000	1.7 c	3.3 c	590.1 a	12.2 c
		2002		
0	6.1 a	11.5 a	545.1 a	16.6 a
4000	2.8 b	5.5 a	572.9 a	13.1 b
8000	1.6 c	3.4 c	583.9 a	11.7 c

Means followed by the same letter(s) within each column do not significantly differ using Duncan's Multiple Range Test.

Carbohydrate content was significantly increased with salinity, but was not significantly differed between moderate and higher salinities (1st season), also in 2nd season, it was tended to be increased with salinity, but not significant.

Of interest to know that carbohydrate tended to be diverted and depleted during salinity in energy dependent ion regulation process (maintenance respiration) (Pasternak, 1987). Herein, this was not the case, it was slightly increased, not greatly expenditure. This confirmed the previously suggested adaptive functions and the characterization of Baladi cowpea as less to moderately sat sensitive cv. On the other hand, protein content. It was significantly decreased with salinity. This was logically true due to the similar effect of salinity on N content (Table 4).

Effect of applying ameliorative ions:

Data of Table 8 showed that phosphate followed by nitrate and citrate were considerably increased K/Na and Ca/Na ratios compared with control. On the other hand, the significant highest carbohydrate content was of

Drew, M.C. and Lauchli, A. (1985). Oxygen-dependent exclusion of Na ions from shoots by roots of *Zea mays*. Plant Physiol., 7:70.

El-Saied, H.M.; Abou-Hadid, A.F. and El-Beltagy, A.S. (1988). The possibility of using ethrel to identify. II. Cowpea (*Vigna sinensis*, L.).

Fathy, El-S.L. El-S.; Abd-Rahman, A.M.M. and Khder, Z.M.A. (2003). Response of broad bean to foliar spray of different K-sources and energy related organic compounds (EROC) to induce better internal K and sugars case towards better growth and productivity. J. Agric. Sci. Mansoura Univ., 28(4):2935-2954.

Grattan, S.R. and Grieve, C.M. (1999). Salinity- mineral nutrient relations in horticultural crops. Scientia Horticulturae, 78:127-157.

Greenway, H. and Munns, R. (1980). Mechanism of salt tolerance in non-halophytes. Ann. Rev. Plant Physiol., 31:149-190.

Hasegawa, P.M. and Bressan, R.A. (2000). Plant cellular and molecular responses to high salinity. Ann. Rev. Plant Physiol., Plant Mol. Biol., 51:463-499.

Helaly, M.N.M.; Salama, A.M. and Arafa, A.A. (1984). Effects of salinity on growth, mineral constituents, water fractions and endogenous growth substances in horse bean plants. J. Agric. Sci. Mansoura Univ., 9(2):251-264.

Horneck, D.A. and Hanson, D. (1998). Determination of K and Na by flame emission spectrophotometry. In Handbook of Ref. Methods for Plant Analysis. Klara, Y.P. ed., 153-155.

Horneck, D.A. and Miller, R.O. (1998). Determination of total N in plant tissue. In Handbook of Ref. Meth. of Plant Analysis. Kalra, Y.P. ed., 75-83.

Kafkafi, U.; Siddiqi, M.Y.; Ritchie, R.J.; Glass, A.D.M. and Ruth, T.J. (1992). Reduction of nitrate ($^{13}NO_3$) influx and nitrogen (^{13}N) translocation by tomato and melon varieties after short exposure to calcium and potassium chloride salts. J. Plant Nutr., 15:959-975.

Kafkafi, U.; Valoras, N. and Letey, J. (1982). Chloride interaction with nitrate and phosphate nutrition in tomato (*Lycopersicon esculentum* L.). J. Plant Nutr., 5:1369-1385.

Lascaris, D. and Deacon, J.W. (1991). Comparison of methods to assess senescence of the tortex of wheat and tomato roots. Soil Biol. & Biochem., 23(10):979-986.

Mahmoud, M.H.; El-Beltagy, M.S. and El-Beltagy, A.S. (1988a). Effect of salinity and soil moisture on growth of lima bean and cowpea.. Egypt. J. Hort., 15(2):129-142.

Mahmoud, M.H.; El-Beltagy, M.S. and El-Beltagy, A.S. (1988b). Tolerance of lima plants *Phaseolus lunatus*, L. to stress conditions. Egypt. J. Hort., 15(2):121-128.

Maiti, R.K.; Garcia-Guzman, J.; Sanchez-Arreola, E.; Ferrari-Legorrwta, R.; Olguin-Tellez, L.P. and Benavidies-Mendoza, A. (2002). Salinity tolerance of different vegetable crop species at the germination and initial seedling stages. Crop Res. (Hisar), 23(3):476-480.

Mansour, A.F.W.; Ahmed, F.F.; Ragab, A.M. and Darwish, G.H. (1998). Effect of organic and amino acids on alleviation the adverse effect of salinity on El-Hamawy apricot seedlings. Egypt. J. Hort., 25(3):359-369.

Mass, E.V. and Hoffman, G.J. (1977). Crop salt tolerance. current assessment. J. Irrig. Drain. Amer. Soc. Civil Eng., 103(R_2):115-134.

Michel, K.A.; Gilles, J.K.; Smith, R.P. and Ramilton, A.F. (1956). Colormetric method for determination sugars and related substances. Anal. Chem., 28:3.

Montero, E.; Cabot, C.; Poschenrieder, C. and Barcelo, J. (1998). Relative importance of osmotic-stress and ion-specific effects on ABA-mediated inhibition of leaf expansion growth in *Phaseolus vulgaris*. Plant Cell and Environ., 21(1):54-62.

Navarro, J.M.; Botella, M.A.; Cerda, A. and Martinez, V. (1999). Yield and fruit quality of melon plants grown under saline conditions in relation to phosphate and calcium nutrition. J. Hort. Sci. Biotech., 74:573-578.

Nieman, R.H. and Clark, R.A. (1976). Interactive effects of salinity and phosphorus nutrition on the concentrations of phosphate and phosphate esters in mature photosynthesizing corn leaves. Plant Physiol., 57:157-161.

Page, A.I.; Miller, R.H. and Kenney, D.R. (1982). Methods of Soil Analysis. Part II. Chemical and Microbial Methods. 2^{nd} ed. Am. Agron., Madison, Wisconsin, USA.

Pasternak, D. (1987). Salt tolerance and crop production, a comprehensive approach. Ann. Rev. Phytopathol., 25:271-291.

Richter, C.; Heiligatag, B.; Nagieb, M. and Mukhallati, U. (1999). The effect of salinity on growth and ion content of chickpea, egg fruit and red pepper varities. Tropenlandwrite, 100(1):3-16.

Sharpley, A.N.; Meisinger, J.J.; Power, J.F. and Suarez, D.L. (1992). Root extraction of nutrients associated with long-term soil management. In: Steward, B. (Ed.). Advances in Soil Science, Vol., 19, Springer, PP. 151-217.

Tawfik, H.A.; Abo El-Sood, I.A. and Maria, A.M. (1977). Effect of salt concentrations on the growth and internal structure of cowpea plants. Ann. Agric. Sci., 20:171.

Turk, K.J.; Hall., A.E. and Asbell, C.W. (1980). Drought adaptation of cowpea, influence of drought on seed yield. Agron. J., 72:413.

West, D.W. and Francois, L.E. (1982). Effect of salinity on germination, growth and yield of cowpea. Irrig. Sci., 3(3):169.

تخفيف التأثيرات الضارة للملوحة على محصول اللوبيا البلدى بإستخدام أيونات الفوسفات والنترات والسترات

السعيد لطفى السيد فتحى
قسم الخضر ، معهد بحوث البساتين بالجيزة ، القاهرة

أجريت تجارب ملوحة (طويلة الأمد) على نباتات اللوبيا البلدى بمزرعة البرامون البحثية خلال عامى ٢٠٠١ ، ٢٠٠٢ (العروة الصيفية) لدراسة تأثير مستويات مختلفة من الملوحة فى صورة كلوريد صوديوم (صفر ، ٤٠٠٠ ، ٨٠٠٠ جزء فى المليون) وتأثير إضافة أيونات الفوسفات (فى صورة حمض فوسفوريك بمعدل ٠,٣٥ مل/لتر) ، النترات (فى صورة حمض نيتريك بمعدل ٠,٣٥ مل/لتر) والسترات (فى صورة حمض ستريك ، ٥ جم/لتر) فى مياه الرى كمعاملات مخففة ومضادة للملوحة وكذلك التفاعل بينها على الأداء الأيونى والفسيولوجى والمحصولى لتلك النباتات بهدف الحصول على إنتاجية مناسبة من القرون الخضراء والبذور الجافة عند الملوحة المتوسطة وتقليل إنخفاض الإنتاجية عند الملوحة العالية. وكانت معاملات الأيونات المضادة للملوحة تضاف فى مياه الرى بمعدل معاملة عقب كل ٣ معاملات ملوحة. وتلخصت أهم النتائج فى الآتى:-

١- **تأثيرات الملوحة:** أدت زيادة شدة الإجهاد الملحى إلى حدوث نقص معنوى فى إرتفاع النبات وتراكم وتوزيع المادة الجافة إلى أجزاء النبات المختلفة والمادة الجافة الكلية وعدد الأزهار وعدد القرون ومحصول القرون الخضراء ومحصول البذور الجافة / نبات (جم) فى كلا الموسمين وإنخفض تراكم المادة الجافة الكلية بمقدار ٢٠,٧ ، ٣١,٠% (متوسط الموسمين بالنسبة للمقارنة) ، ومحصول القرون والبذور بمقدار (٢٤,٨ ، ٢٥,٦%) ، (٤٦,٨ ، ٤٧,٠%) (متوسط الموسمين بالنسبة للمقارنة) عند مستوى الملوحة المتوسطة والعالية (٤٠٠٠ ، ٨٠٠٠ جزء فى المليون كلوريد صوديوم) على التوالى. وكان ذلك راجع لزيادة إختيارية إمتصاص ونقل وتراكم الصوديوم على حساب البوتاسيوم والكالسيوم (قيم منخفضة للبوتاسيوم / الصوديوم ، الكالسيوم / الصوديوم) وتراكم الكلوريد ونقص النتروجين والفوسفور والمغنسيوم ومحتوى البروتين الخام.

٢- **تأثيرات الأيونات المضادة للملوحة:** أدت إضافة أيونات الفوسفات يليها النترات ثم السترات فى مياه الرى إلى حدوث تحسن معنوى واضح فى كل صفات النمو والإزهار والإثمار والمحصول وكان ذلك راجع إلى تحسن الأداء الأيونى والفسيولوجى متمثلا فى زيادة إختيارية إمتصاص ونقل وتراكم البوتاسيوم والكالسيوم على حساب الصوديوم ، قيم مرتفعة (بوتاسيوم / صوديوم ، كالسيوم / صوديوم) ونقص تراكم الكلوريد وزيادة محتوى النتروجين والفوسفور والمغنسيوم والكربوهيدرات الكلية والبروتين الخام. وأدت إضافة الأيونات بالترتيب السابق إلى زيادة تراكم المادة الجافة الكلية بمقدار ٥١,٩ ، ٤١,٤ ، ٢٥,٧٢% ، وزيادة فى محصول القرون والبذور بمقدار (٤٦,٥ ، ٤٧,٧%) ، (٣١,٠ ، ٣٢,٤%) ، (٢٢,٣ ، ١١,٤%) (متوسط الموسمين نسبة إلى المقارنة) على التوالى.

٣- **تأثير التفاعل:** أدت إضافة أيونات الفوسفات والنترات والسترات إلى حدوث تحسن كبير (الإستعادة إلى الحالة الطبيعية) فى كل الصفات المدروسة عند الملوحة المتوسطة وبدرجة معقولة عند الملوحة العالية. حيث كان النقص فى تراكم المادة الجافة الكلية بمقدار ٣٠,١ ، ٤٣,٠% مع الملوحة المتوسطة والعالية على التوالى ، وأدت إضافة الفوسفات والنترات حدوث زيادة بمقدار ١٠,٠ ، ١,٥% على التوالى ، بينما أدت السترات إلى إنخفاض النقص إلى ٦,٢% (عند الملوحة المتوسطة) وعند الملوحة العالية إنخفض النقص فى تراكم المادة الجافة ليصبح فقط ٣,٩ ، ١١,٤ ، ١٤,٦% لكلا من الفوسفات والنترات والسترات على التوالى. كذلك إنخفض محصول القرون والبذور عند الملوحة المتوسطة بمقدار (٣٠,٧ ، ٣٢,٨%) وعند الملوحة العالية بمقدار (٥٤,٢ ، ٥٢,٠%) لكلا منهما على التوالى. وأدت إضافة

الأيونـات إلـى تغيير الوضـع فقد حـدثت زيـادة فـى محصـولى القرون والبـذور مقدارها (٤,٣ ، ٤,٩%) عند الملوحة المتوسطة وإنخفض النقص عند الملوحة العالية ليصبح ٢٥,٠ ، ٢٦,٥% نتيجـة لإضـافة الفوسـفات. وبالنسبة للنتـرات إنخفض الـنقص ليصبح فقـط (٣,٦ ، ٢,٨%) ، (٣٤,٦ ، ٣٤,٥%) والسـترات ليصـبح (٢٠,٢ ، ١٩,٧%) ، (٣٨,٣ ، ٣٨,١%) لمحصـولى القرون والبذور وعند الملوحة المتوسطة والعالية على التوالى. وكان كل ذلك راجع للتأثيرات المفيدة على الحالة الأيونية والفسيولوجية وتقليل تراكم الأيونات الملحية الضـارة وزيـادة محتوى العناصر المعدنية المفيدة وكذلك الكربوهيدرات الكلية والبروتين الخام.

٤- جـاءت نتـائج الإرتبـاط الإحصـائى مؤكدة للنتـائج ولتفسير الآداء المحصـولى علـى أسـاس الآداء الأيونى والفسيولوجى وكان الإرتباط بين محصـولى القرون والبذور موجب مـع المـادة الجافة الكليـة ، الكربوهيـدرات الكليـة ، البـروتين الخـام والعناصـر المعدنيـة (النتـروجين والفسـفور والبوتاسيوم والكالسيوم) وقيم (البوتاسيوم / الصـوديوم) ، (الكالسيوم / الصـوديوم) وسـالب مـع محتوى النبات من الصوديوم والكلوريد. كذلك تؤكد على أهميـة قيم (البوتاسيوم / الصـوديوم) ، (الكالسوم / الصـوديوم) وكذلك المحتوى البروتينى ومحتوى الصوديوم والكلوريد كأسس معبرة عن الآداء الأيونى والفسيولوجى المتعلق بالتحمل والتأقلم أو الحساسية للملوحة.

٥- إعتبـار اللوبيـا البلدى نبـات قليل الحساسية نسبيا للملوحـة المتوسطة (٤٠٠٠ جزء فـى المليون كلوريـد صـوديوم) ومعتدل الحساسية عند الملوحـة العاليـة (ضـعف التركيـز المتوسـط) وذلـك بإعتبار التغيرات غير المتطرفة فى الآداء الأيونى والفسيولوجى والمصـحوبة بسلوك مماثـل فـى الآداء المحصـولى عند تضـاعف الملوحـة مـن ٤٠٠٠ إلـى ٨٠٠٠ جـزء فـى المليـون كلوريـد صوديوم.

٦- نوصـى فى النهاية بإضافة أيونات الفوسفات فى صورة حمض فوسفوريك فـى مياه الرى بمعدل ٠,٣٥ مل/لتر ، ٣ إضافات (الشهر الثانى والثالث والرابع بعد الزراعة) لتحسين النمو وزيادة إنتاجيـة القرون الخضـراء والبـذور الجافـة للوبيـا تحت ظـروف ملوحـة مماثلـة. كذلك لإضـافة حمض النتريك أو الستريك فى مياه الرى تأثيرات مفيدة تحت نفس الظروف.