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Full Length Research Paper

Examining Soil Salinity and Alkalinity: Implications for Vegetable Crop Germination and Seedling Growth in the Office du Niger Zone

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In 2010 and 2011, pot experiments were conducted at Niono Agronomic Research station to determine soil alkalinity/salinity effects on seed germination and seedling growth of vegetable crops. Three types of soil types with physical sign of salt effects were used for these experiments: salt affected black soil, salt affected white soil and soil presenting no physical sign of salinization. The test crops where 5 varieties of tomato, 5 varieties of cabbage, 5 varieties of onion, 5 varieties of okra and 2 varieties of red pepper. Three types of experiments were conducted: germination tests, seedling survival test and soil amendment test. The experiments were run in a randomized complete block design, using split pot treatment arrangements with soil types as main plot factors and crop varieties as secondary plot factors treatments. Each crop was grown in a separate experiment. The results of this study showed that the varieties of the different crop species generally are very sensitive to salt stress and none of them showed sign of resistance to salinity or alkalinity stress. While all species had high percent germination (95 to 98%) in the non-affected soil, none of them germinated in black or white salt soils indicating the seed quality was not a problem. Tomato, cabbage and onion are particularly sensitive to germination stage and seedling stage. Soil washing could mitigate salt effects on seedling growth but does not seem adequate for the total germination of seeds. Combination of organic amendments and soil washing reduced salt effects but did not insure satisfactory plant growth conditions. It was concluded that in the high alkaline soil, tomato, cabbage, onion and red pepper crops are not suitable.

Keywords: Alkalinisation/salinization, vegetable crop, tomato, onion, okra, cabbage, red pepper, germination percentage, seedling growth, Office du Niger.

INTRODUCTION

From subsistence farming, gardening has become a real diversification activity in the Office du Niger, offering producers a prospect of additional income. However, it has been recognized that gardening seriously affects the physico-chemical properties of soils (Jamin and Doucet, 1994). Because of the method of irrigation, gardening favors high capillary rise of irrigation water and causes high salt concentration in the top twenty centimeters of the soil (Jamin and Doucet, 1994). In the Office du Niger zone of Mali, processes of salinization / alkalization are well known (Esther Lopez TORRES, 1997; Ndiaye et al., 1998, Marlet et al., 1998, Dicko et al., 2005). These processes are evolving and represent a potential danger for the development of horticulture in the Office du Niger. Studies conducted under the regional hub for research on irrigation systems (PSI) showed that the risk of soil degradation by alkalinization / sodisation is much more pronounced in the vegetable plots than in the rice plots. The salt balance is positive for the off-season crops due to large seepage losses in irrigation canals. Rice is less affected by this phenomenon because flooding conditions favor the dissolution of salts and reduce their concentration in the root zone of the plants. The

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phenomenon appears to be a serious threat to the development of gardening if preventive measures are not considered.

The process of soil degradation is related to the dynamics of ground water which is dependent on soil type, cropping systems and the state of irrigation networks (PSI, 1999). The risk of soil degradation through alkalinization / sodisation processes is related to irrigation and farming practices of vegetable crops (Marlet et al., 1998). The permanent presence of irrigation water in the channels required by the irrigation method (channels permanently filled with water) and the use of minimum water through hand sprinkling of water on soil surface cause high capillarity rise and the concentration of salts in the twenty cm of soil layer (Jamin and Doucet, 1994).

In the Office du Niger, the area covered by vegetable crops is less than 4% of irrigated land and Niono is the most diversified area with garden crops. Cultivated land with commercial vegetable crops in Niono during off-season 1995/1996 was estimated to about 677 ha including 300 ha in the locker Retail (Coulibaly and Belières 2005). A survey conducted in Niono area in 1996 showed that producers are more and more getting interest in developing marketable gardening crops and that this activity is expected to growth rapidly in medium term.

Very little information is available on research on salinity response of vegetable crops in general (Shannon and Grieve, 1999) and particularly in the Office du Niger zone. Several studies have revealed that salinity affects germination and seedling growth in vegetable crops (Schimidhlter and Gertli, 1990; Crucci et al., 1994). Maiti et al. (2004) reported significant variability to salinity tolerance among some vegetable crop species. Among them celery showed higher level of tolerance followed by cabbage, beet leaves, green tomato. Salinity affected the quality and productivity of vegetables (Yo and Shaw, 1990; Singh and Mangal, 1991; Pascale and Barberi, 1995; Sharma et al., 2001). It is reported that at certain concentrations, saline water might be utilized to irrigate vegetable crops (Kowaski and Pailada, 1995). Maiti et al. (2007) reported variability in salinity tolerance and osmotic stress among vegetable crop species. Okra showed highest level of tolerance to salinity. Genotypic variability in salinity tolerance at the seedling stress has been reported among tomato varieties (Maiti et al., 2007).

The present study was aimed at determining the impact of soil salinity/alkalinity on germination rates of vegetable crops, seedling survival and plant growth and development in salt affected soils of the Office du Niger.

MATERIALS AND METHODS

Different experiments were conducted with different vegetable crop species for salinity/alkalinity tolerance using high salt affected soils from vegetable growing land areas of the Office du Niger. The experiments were conducted at the agronomic research station of the Regional Centre of Agronomic Research of Niono (CRRA-N) in Office du Niger zone. The Office du Niger is situated in the interior delta of the Niger River which extends in the North-eastern direction (between 13° and 15° latitudes North and 4°-6° Western longitudes). The climate is of Soudano-Sahélienne type, characterized by a rainy season (mid-June to October), a cold season (November-semi-February) and a hot season (mid-February mid-June). The average annual rainfall varies between 450 and 600 mm depending on the years. With climatic change, the rainfall pattern is taking shape toward the lower limit of 450 mm per year. The average temperature varies between 14° and 40°C (with the minimum in January-February and the maximum in April-May). The prevailing winds are harmattan (wind blowing north to south between November and April) and the monsoon which is a fresh wind (blowing south-north) from May to October.

Experiment 1

Impact of alkalinity and salinity on the rate germination of vegetable crops

For this study soil samples collected from salt affect areas presenting physical characteristics such as black and white efflorescence were used. As control, samples from soil showing no signs of degradation (healthy soil) were collected. These soil samples were used in pot experiment. The pots used were made of vegetation plastic buckets with a capacity of about 1 kg of soil. Crop tests were tomato, onion, pepper, cabbage and okra. These cultures were subjected to the following treatments:

T1: Soil collected in plots with patches of white efflorescence (white salt soil)

T2: Soil collected in plots with black spots efflorescence (black salt soil)

T3: Sol showing no signs of salinity or alkalinity (normal soil)

Experiment design: Randomized Complete Blocks Design (RCBD) with 4 Replications

Experiment 2

Impact of organic amendments on the growth of vegetable crops on alkaline soil

For this experiment soil samples were collected from plots with patches of black and white efflorescence. As control plots soil showing no signs of degradation was sampled. The pots were made of plastic buckets with a

Table 1. Treatments being compared to determine the impact of organic amendments on crop growth.

T1	Control	
T2	Green manure (15 Tons ha^{-1})	
T3	Farmyard manure (15 Tons ha^{-1})	
T4	Rice husk (15 Tons ha^{-1})	
T5	Chemical fertilizer	(dose recommandée)
T6	Green manure 7.5 Tons ha^{-1} +	Farmyard manure 7.5 Tons ha^{-1}
T7	Green manure 7.5 Tons ha^{-1} +	Rice husk 7.5 Tons ha^{-1}
T8	Farmyard manure 7.5 Tons ha^{-1} +	Rice husk 7.5 Tons ha^{-1}
T9	Green manure 15 Tons ha^{-1} +	Recommended fertilizer
T10	Farmyard manure 15 Tons ha^{-1}+	Recommended fertilizer
T11	Rice husk 15 Tons ha^{-1} +	Recommended fertilizer
T12	Green manure 7.5 Tons ha^{-1} +	Farmyard manure 7.5 Tons ha^{-1} + Recommended fertilizer
T13	Green manure 7.5 Tons ha^{-1} +	Rice husk 7.5 Tons ha^{-1} + Recommended fertilizer
T14	Farmyard manure 7.5 Tons ha^{-1} +	Rice husk 7.5 Tons ha^{-1}+ Recommended fertilizer
T15	Green manure 5 Tons ha^{-1} +	Farmyard manure 5 Tons ha^{-1} + Rice husk 5 Tons
T16	Green manure 5 Tons ha^{-1} +	Farmyard manure 5 Tons + Rice husk 5 Tons +Recommended fertilizer

capacity of about 1 kg of soil.
Sol 1: white salt soil
Sol 2: Black salt soil
Sol 3: Normal soil

Each soil type received organic amendments based on Table 1

Experiment design

Randomized Complete Blocks Design (RCBD) with 4 Replications

Experiment 2 was run in two series: the first series was run without soil washing and the second series with soil washing.

Series 1

Without soil washing

In this series, the soils were used as they came from the fields. They have not undergone any preliminary washing. The objective was to determine the direct effect of salt ions on plant growth and development. Vegetable crops were direct seeded and the percent germination was recorded.

Series 2

With soil washing

In this series, the soils went through a washing process using fresh irrigation water. The washing consisted to flood the pots with irrigation water and then pour off the excess water after 24 hours. The objective of this washing was to let dissolved enough salt in flooding water and then to evacuate the excess salt. The washing process was repeated twice before seedlings were transplanted. This series was designed to see if the effect of salts on germination could be mitigated by soil leaching. Vegetable plants were either direct seeded or transplanted at 3 to 4 weeks seedling stages. The percent germination and seedling survival were recorded.

Raising vegetable seedling plants in nursery

The seedling bed was carefully prepared on normal soil before sowing the vegetable crops. The nursery plot was hand plowed using traditional “hoe” and then manually harrowed and leveled. The seedbed was kept moist for two days then seeds were planted. The nursery was kept moist until full germination then regularly irrigated as needed without flooding. The nursery was maintained for three to four weeks before seedling were transferred in experimental pots.

Preparation of the experimental pots

Pots of about 1 kg capacity were filled with different types of soil. Before potting, the soil types were well homogenized separately in order to reduce the gap variation between pots. Representative soil samples were then taken and sent to the soil water laboratory at Sotuba research station before the experiment was installed.

Table 2. Chemical composition of the soil used

	Soil type		
Soil characteristics	**Normal soil**	**Salt affected white soil**	**Salt affected black soil**
pH (eau)	5,79	7,76	10,06
pH (KCl)	4,59	7,20	9,27
Specific Conductivity (mmho/cm 25 °C)	0,08	1,90	1,63
Organic carbon (% C)	0,59	0,47	0,50
Total Nitrogen (%N)	0,10	0,08	0,05
Available Phosphorus (ppm P)	23,99	19,60	24,92
ESP (%)	1,06	17,97	22,73
CEC ammonium Acetate (meq/100g)	4,99	7,77	21,01
Ca exchangeable " "	2,40	2,30	3,31
Mg " " "	1,25	1,19	1,65
K " " "	0,35	0,16	0,34
Na " " "	0,25	3,57	4,79
Available Potassium (mg/100g)	6,36	3,87	8,85

Samples were analyzed to determine pH, electrical conductivity, phosphorus, nitrogen, potassium, and CEC sum of exchangeable bases.

Direct sowing

Sowing was done at 6 grains per pot for gumbo, 20 seeds per pot for tomato, cabbage for 20 grains, 20 grains to 20 grains for onions and peppers.

Watering

This operation was carried out morning and evening using a conventional watering method of vegetable crops. The amount of water used for irrigation has not been measured, but care was taken to keep the soil moist and prevent excess water in the pots.

Transplanting seedlings

Transplanting seedlings in pots vegetation took place 3-4 weeks after sowing in the nursery. The seedlings were then monitored daily and regularly watered.

Data collection

Number of germinated seeds was recorded daily (germination rate), and the final germination percentage was determined after 10 days. Seedling height, number of leaves and dry weights of seedling recorded at 40 days after sowing.

Statistical analysis

The analysis of variance (ANOVA) was run on all measured parameters using the GENSTAT software discovery edition 4. Mean separation was done using the standard error of the difference of the means (SED).

RESULTS AND DISCUSSION

Chemical composition of the soils

The results presented in Table 2 show that the healthier soil (normal soil) was acid (pH =5.79) while the salt affected white and black soils were alkaline. PH and electrical conductivity (EC) are simple indicators that are used in the evaluation of salinity and alkalinity. The specific electrical conductivity value for normal soil was much lower (0.08 mmho/cm) than the values for white salt and black salt soils (1.90 abd 1.63 mmho/cm respectively). In addition to soil pH and electrical conductivity, the exchangeable sodium percentage (ESP) values indicated that both white and black salt soils were developing toward alkalinity. In general white salt soil was evolving much more toward neutrality than alkalinity because the pH was closer to neutrality (7.76) than black salt soil (10.06). Neutral salinity is usually characterized by pH close to neutrality and high electrical conductivity due to high neutral salt content which result in white efflorescence on soil surface (Esther Lopez Torres, 1997). According to Esther Lopez Torres (1997) at high alkalinity (pH value of 10 more), the soil organic matter compounds degrade and dissolve quickly in soil solutions and rise on top to give the dark color to the soil (black salt soil).

In general, the soil organic carbon and nitrogen concentrations were low for all soil while the levels of available phosphorus were within acceptable range for all soils (19.6 to 24.92 ppm P).

Table 3. Some chemical characteristics of the organic amendment used

Organic amendments	%C	% N	C/N	% P_2O_5	% K_2O
Farmyard manure	98,03	7,99	12	1,02	0,89
Rice husk	84,60	3,35	25	0,21	0,29
Green manure (Azola)	79,57	8,22	10	0,22	0,73

Table 4. Effect of salt ions on the rate of germination (%) of okra, tomato, cabbage, onion and red pepper varieties used in 2011

Species and Varieties		Salt affected white soil	Salt affected black soil	Normal soil
Okra varieties			% germination	
1.	Keleya	1.2	0	95
2.	Sabalibougou	2.1	0	90
3.	Volta	1.1	0	95
4.	Indiena	0	0	87
5.	Loli	0	0	89
Tomato varieties				
1.	Estrela	1,0	0	90
2.	Formosa	1.1	0	97
3.	c-20-5	0.1	0	94
4.	SF 8361	0	0	87
5.	Mongol	0	0	89
Cabbage varieties				
1.	KK Cross	2.2	0	95
2.	Africa cross	1.1	0	90
3.	F1 Tropica cross	0	0	95
4.	F1 Sahel	0	0	77
5.	F1 Mont Perte	1.2	0	95
Imported Onion varieties				
1.	Violet de galmi	0	0	97
2.	Blanc de galmi	0	0	98
3.	Early Texas grano	0	0	95
4.	Rouge de Tana	0	0	97
5.	Red Creole	0	0	95
Red pepper varieties				
1.	Safi	0	0	95
2.	Jaune du Burkina	0	0	90

Chemical characteristic of the amendments used

The results of chemical analysis of organic amendment samples chowed C/N ratios of 12 for farmyard manure, 10 for green manure and 25 for rice husk (Table 3). Nitrogen concentration was low for rice husk but high for farmyard manure and green manure. In general, phosphorus and potassium concentration were low for all organic amendment sources.

Percentage of germinated seed of different crop species in salt affected soils

The germination test results reported in Table 4 show high germination rates of all crops (okra, tomato, cabbage, onion and pepper) grown in healthy soil. The germination rates were 87-95% for okra, 87 to 97% for tomato, 77 to 95% for cabbage, 90 to 95% for onions and peppers. However, none of the crops germinated in black

Table 5. Plant survival in different salt affected soil types one week after transplantation

Treatments	cabbage	Tomato	Onion
Soil type			
Normal soil	86.5	85.0	99.61
White salt soil	15	3	0
Black salt soil	0	0	0
Ftest sol	<0.001	<0.001	<0.001
CV	35.3	40.7	27.3

salt or in white salt soils. In pots containing white salt, some seed of okra (keleya, Sabalibougou and Volta), tomato (Estrela, Formosa, c-20-5) and cabbage (KK Cross, Africa and F1 cross Mont Loss) initiated germination, but the seedling died within two or three days later (Table 4). In contrast crops such as onion and red peppers never initiated sprouting in white salt soils. In the black salt soil none of the crops showed a sign of seed germination. Although the experiments were repeated twice each year, no significant difference were observed in the germination pattern of all crop used. High germination rate in healthy soil indicated that the quality of the seeds could not be claimed as cause of their poor performance in salt affected soils.

Seedling survival and growth after transplanting in non-washed soils

The results (Table 5) did not show any significant differences between varieties within crop species. However, seedling survival was significantly influenced by soil type. In normal soil, cabbage and tomato had lower but similar survival rate (86.8 and 85.0% respectively) as compared to onion (99.6%). In contrast, cabbage and tomato had only 15% and 3% survival rates in white salt, and none of these two crops did survive in black salt soil. The percent survival of onion was null in all salt affected soils.

Seedling survival and growth after transplanting in washed soils

To see if the effect of salts on germination could be mitigated by soil leaching, young seedlings were transplanted in pots that went through soil washing process as described the above in material and method. The survival percentage of cabbage, tomato and onions one week after transplanting was higher in washed soil than in non-washed soils. However, most of the plants died after two weeks of vegetation. This indicated that the two washing processes were not enough to remove the adverse effects of salt ions.

Effects of organic amendments and soil washing on the growth of vegetable crops on alkaline soil

The objective of soil amendment was to improve the physical conditions of the soils and to increase plant nutrient uptake that would promote the production. The survival rate of seedlings is reported in Table 6. As it can be observed in the table, the survival rates were much improved compared to previous experiments. In general, no significant differences were observed between different soil amendments (T1 to T16) using cabbage, tomato and onion. Survival percentage ranged from 42.7 to 60.40% for cabbage, 37.5 to 63.5% for tomato and from 76.04 to 84.46% for onion. These results indicated that soil organic amendments can significantly improve the growth conditions of vegetable crops under high salt stress. When comparing within soil types, it can be observed from table 6 that survival percentage in black salt soil was much lower ($P<0.001$) than in other soils. Two weeks after transplanting the percent survival was 6.8% for cabbage, 41.8% for tomato and 41.8% for onion. In contrast in white salt soil, the survival percentage was 60.2% for cabbage, 59.6% for tomato and 98.05% and in normal soil the survival rates were 86.5, 85.0 and 99.6%. However four weeks after transplanting, more than 50% of the plants died in all pots except in normal soil pots.

Seedlings that survived were followed until harvest. The results of dry matter weights are presented in Table 7. Onion could not survive longtime in salt affected soil. The few seedlings that were observed 15 days after transplanting died prematurely and there was nothing left at harvest. The growth and development of cabbage plants were also poor and only few plants could be harvested. Only tomato was able to give some fruits. The data presented in table 7 show the dry matter weigh of tomato and cabbage. The ANOVA run on the dry matter weights of cabbage and tomato straw showed no significant difference between treatments. However, the fruit weight of tomato indicated higher values for some treatments (T1, T2, T3 and T16 ($P <0.001$) but the coefficient of variation was too high (71%) to comment on these differences.

Table 6. Plant survival in different salt affected soil types two weeks after transplantation

Treatments	cabbage	Tomato	Local onion
		Survival %	
T1	53.1	49.0	76.04
T2	56.2	37.5	80.21
T3	47.9	53.1	82.29
T4	50.0	47.9	80.21
T5	57.3	54.2	79.17
T6	58.3	63.5	80.21
T7	50.0	52.1	81.25
T8	46.9	59.4	78.12
T9	60.4	53.1	83.33
T10	51.0	45.8	86.46
T11	55.2	45.8	77.08
T12	49.0	44.8	75.00
T13	57.3	50.0	78.12
T14	58.3	49.0	81.25
T15	42.7	49.0	78.12
T16	54.2	53.1	80.21
Ftest Treatment	0.617	0.423	0.831
SED	7.63	8.38	4.995
Soil type			
Normal soil	86.5	85.0	99.61
White salt soil	60.2	59.6	98.05
Black salt soil	12.3	6.8	41.80
Ftest soil type	<0.001	<0.001	<0.001
SED	3.31	3.63	2.163
Treatment x soil type	0.624	0.840	0.758
SED	13.22	14.51	8.652
CV	35.3	40.7	27.3

T1	Control			
T2	Green manure (15 Tons ha^{-1})			
T3	Farmyard manure (15 Tons ha^{-1})			
T4	Rice husk (15 Tons ha^{-1})			
T5	Chemical fertilizer		(dose recommandée)	
T6	Green manure 7.5 Tons ha^{-1}	+	Farmyard manure 7.5 Tons ha^{-1}	
T7	Green manure 7.5 Tons ha^{-1} +		Rice husk 7.5 Tons ha^{-1}	
T8	Farmyard manure 7.5 Tons ha^{-1} +		Rice husk 7.5 Tons ha^{-1}	
T9	Green manure 15 Tons ha^{-1}	+	Recommended fertilizer	
T10	Farmyard manure 15 Tons ha^{-1} +		Recommended fertilizer	
T11	Rice husk 15 Tons ha^{-1} +		Recommended fertilizer	
T12	Green manure 7.5 Tons ha^{-1}	+	Farmyard manure 7.5 Tons ha^{-1}	+ Recommended fertilizer
T13	Green manure 7.5 Tons ha^{-1} +		Rice husk 7.5 Tons ha^{-1} + Recommended fertilizer	
T14	Farmyard manure 7.5 Tons ha^{-1} +		Rice husk 7.5 Tons ha^{-1} + Recommended fertilizer	
T15	Green manure 5 Tons ha^{-1}	+	Farmyard manure 5 Tons ha^{-1} +	Rice husk 5 Tons
T16	Green manure 5 Tons ha^{-1}	+	Farmyard manure 5 Tons + Rice husk 5 Tons +Recommended fertilizer	

GENERAL DISCUSSION

Excessive levels of soluble salts in the soil, particularly sodium chloride, cause poor plant growth. In the present study, high pH values (7.67 - 10.06) of the salt affected soils and high exchangeable sodium percentage (Table 2) indicate that the soils were going under alkalinisation processes. Excessive soil alkalinity means that there are

Table 7. Fruit and straw weight of tomato, cabbage and locl onion

Treatments	tomato fruit weight (g/pot)	Tomato straw weight (g/pot)	Cabbage leaves (g/pot)	Onion dry matter (g/pot)*
T1	4.31		0.728	-
T2	3.68	0.917	0.712	-
T3	2.89	1.227	0.524	-
T4	2.40	0.913	0.657	-
T5	1.68	0.877	0.825	-
T6	1.08	1.329	0.938	-
T7	1.19	1.007	0.855	-
T8	2.01		0.585	-
T9	1.54	1.196	0.743	-
T10	1.16	1.269	0.546	-
T11	1.71	0.722	0.784	-
T12	1.94	0.907	0.712	-
T13	1.52	0.814	0.715	-
T14	1.86	1.025	0.779	-
T15	2.83		0.871	-
T16	3.66	1.562	0.846	-
F test	<0.001	<0.508	0.285	-
SED	0.646	0.3267	0.1530	-
Soil type				-
Normal soil	6.65	1.665	1.232	-
White salt soil	0.00	0.961	0.619	-
Black salt soil	0.00	0.565	0.356	-
Ftest	<0.001	<0.001	<0.070	-
SED	0.280	0.1415	0.0663	-
Interaction Treatment x soil type	<0.001	<0.070	0.128	-
SED	1.120	0.5659	0.2650	-
CV	71.5	75.2	50.2	-

*- not estimated

T1	Control		
T2	Green manure (15 Tons ha^{-1})		
T3	Farmyard manure (15 Tons ha^{-1})		
T4	Rice husk (15 Tons ha^{-1})		
T5	Chemical fertilizer	(dose recommandée)	
T6	Green manure 7.5 Tons ha^{-1} +	Farmyard manure 7.5 Tons ha^{-1}	
T7	Green manure 7.5 Tons ha^{-1} +	Rice husk 7.5 Tons ha^{-1}	
T8	Farmyard manure 7.5 Tons ha^{-1} +	Rice husk 7.5 Tons ha^{-1}	
T9	Green manure 15 Tons ha^{-1} +	Recommended fertilizer	
T10	Farmyard manure 15 Tons ha^{-1} +	Recommended fertilizer	
T11	Rice husk 15 Tons ha^{-1} +	Recommended fertilizer	
T12	Green manure 7.5 Tons ha^{-1} +	Farmyard manure 7.5 Tons ha^{-1}	+ Recommended fertilizer
T13	Green manure 7.5 Tons ha^{-1} +	Rice husk 7.5 Tons ha^{-1} + Recommended fertilizer	
T14	Farmyard manure 7.5 Tons ha^{-1} +	Rice husk 7.5 Tons ha^{-1} + Recommended fertilizer	
T15	Green manure 5 Tons ha^{-1} +	Farmyard manure 5 Tons ha^{-1} +	Rice husk 5 Tons
T16	Green manure 5 Tons ha^{-1} +	Farmyard manure 5 Tons + Rice husk 5 Tons +Recommended fertilizer	

too many hydroxyl ions (OH–) in the soil solution. An excess of OH– increases the soil pH. Excessively high soil pH causes deficiencies for iron, manganese, copper and zinc and, depending on parent material, may also cause boron toxicity (Castalanelli, 2009, Cox and Koenig, 2010). The adverse effects of salinity/alkalinity on seed germination can be explained by the intake of toxic ions, which may change certain enzymatic or hormonal activities or by decreasing absorption of water, because activities and events normally associated with germination can be either delayed and/or proceed at reduced rates (Kaveh et al., 2011). Cuartero and Fernandez-Munoz (1999) reported that seeds need 50% more days to germinate at EC = 1.4 than in a medium without salt and almost 100% more days at EC = 3.4. Neamatollahi et al. (2009) also reported that salinity may reduce germination percentage due to higher osmotic pressures.

Ideally, the excess salts need to be leached out of the soil. The efficiency of soil flushing to evacuate salts outside the plots was reported by F.Ouvry et al. (1999). However, it is recognized that it may take many years to keep the salts out or below the root zone. The objective of soil washing in the present study was to attenuate the adverse effects of salt ions in the root zone. However, no germination was observed after soils went through two washing processes.

Seed germination and seedling growth are the most sensitive stages to environmental stresses in general and salt stress in particular (Keveh et al., 2011). In the present study young seedlings raised in normal soil could not survive, when transplanted in black or in white salt soils. This indicated that no tolerant lines can be screened among all the tested vegetable crop species. Foolad and Lin (1997) reported absence of generic relationship between salt tolerance during seed germination and vegetative growth in tomato. This indicated that screening crops at germination and seedling stages for salt tolerance may not be reliable to distinguish a mature plant as tolerant or sensitive, because the ability of plants to tolerate salt is determined by multiple factors and pathways. Among others, the ability of plant to detoxify toxic ions of salt affected soils is probably the most critical pathway (Foolad and Lin, 1997).

Research results indicated that organic fertilization increased salt tolerance of some vegetable crops under saline conditions (El-Missery, 2003 on cabbage and spinach; Saleh et al., 2003 on onion, Abou El-Magd et al., 2008 on sweet fennel plant). Freshly incorporated organic matter in the soil releases plant-available phosphorus as it decays. Also, phosphorus that is bound to soil particles can be accessed by some soil fungi such as mycorrhizae, passing the phosphorus onto the plant. These fungi form special relationships with the plant root; however, their populations decline if too much phosphorus is added to the soil.

CONCLUSION

The process of alkalizing / salinization is a real danger for the development of horticulture. The results of this study show that vegetable crops generally practiced currently in the Office du Niger are very sensitive to stress salinization / alkalization. Among the varieties of the species tested, none showed any sign of resistance. Tomato, cabbage, shallots are particularly sensitive to germination stage and seedling stage. Leaching can mitigate but does not seem adequate for the total germination of seeds. Organic amendments did not improve the situation. These crops should be avoided if possible in highly alkaline soil.

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