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Effects of 0.0 to 5.0dSm-1Concentrations of NaCl, CaCl2 and CaCO3 Salts on Photosynthetic Ability and Yield of some Cowpea Cultivars [Vignaunguiculata (L) Walp]

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Abstract
The current global warming with its resultant climatic changes being experienced are gradually increasing the salt content of soils, challenging and threatening plant growth, making them to thrive poorly and agricultural practices difficult and costly leading to poor crop yield. Little researches have been done to investigate the response of our common crop plants to salinity and to other ever increasing environmental stress. Therefore, this research was conducted at Hadejia-Jamaare River Basin Irrigation Scheme sites in Auyo and Ayama, Jigawa State, Nigeria, to determine the effect of varying concentrations of Sodium Chloride (NaCl), Calcium Chloride (CaCl2) and Calcium Carbonate (CaCO3) with ECe values of 0.0, 2.0, 3.0, 4.0and5.0dSm-1. These were evaluated on photosynthetic ability and yield of IT97K-452-2, IT04K-332-1, IT98K-503-1, and Dan Wuri Cowpea varieties. Result revealed that photosynthesis significantly (P≤0.05) decreased with increase in salt and yield of the plants were significantly inhibited at 4.0dSm-1 and 5.0dSm-1. CaCO3 and CaCl2 greatly suppressed photosynthesis and yield. Improved varieties performed better but local varieties thrive poorly. IT97K-452-2 appeared most tolerant and Dan Wuri most susceptible. Yield significantly decreased with increased concentration with 0.0dSm-1 and 2.0dSm-1 producing higher pod and grain yields. It is recommended that screening exercise in respect of salinity tolerance of other varieties of this and other crops should be carried out prior to cultivation for optimum yield and factors responsible for increasing salinity should be studied more and checked to avoid its resulting decrease in photosynthetic ability and yield of crop plants.

Keywords: Salt, Photosynthesis, Cowpea, Concentration, Yield

Introduction
Cowpea [Vignaunguiculata (L.) Walp] is a dicotyledonous spermatophyte plant belonging to the family Fabaceae. It is an annual crop plant grown globally and adapted to different world climatic conditions. The crop is widely cultivated in Nigeria for the consumption of its grain, green pods and sometimes leaves while the haulms is fed to livestock. The current global climatic change is affecting all agricultural and other human activities. Flooding and drought resulting from the change, fertilizer applications in our farm lands and irrigation techniques employed today are gradually deflating our soil nutrients and dangerously making it more saline thereby decreasing our soil and crop productivity and hence challenging food security.

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(FAO and IFAD, 2012;). While some plants can tolerate salts, some cannot. To what extent salinity affects metabolic activities like photosynthesis remain interesting to many scholars. (Alcamo et al., 2007). Together with the ongoing global salinization, with 7% of the world's total land area affected by salt and about 20% of the irrigated land affected (Szabolcs, 1994; Yeo, 1999; Smedema and Shiati, 2002), this emphasizes the importance of exploring the use of salt resistant varieties of crops to meet our food demand. Many research work done on cowpea were mainly to improve their resistance to pests and diseases, on breeding and response of the crop to different nutrients while little is done to determine the tolerance to ever increasing environmental stress. (Maiti et al., 2006). Soils found in the Savanna are experiencing serious climatic changes that affect plant's growth and therefore food production. The response of cowpea cultivars under different environmental conditions need to be investigated. This is the focus of this research work.

Materials and Methods

Experimental Site: The research was carried out in the Phase II Irrigation Project of Hadejia-Jamaare River Basin Development Authority, Auyo Local Government Jigawa State, Nigeria at Auyo Sector and Ayamasector, Lat 10′ 12″ 45 and Long 9′ 32″ 13 and Lat 10′ 11″ 65 and Long 9′ 22″ 10, using surface running water and ground water respectively.

Treatment Combinations and Experimental Procedure: The research subjects were four cowpea cultivars; IT97K-375-4, IT04K-453-1, IT98K-503-1, and Dan Wuri obtained from International Institute for Tropical Agriculture (IITA) Kano Station. The cultivars will henceforth be referred to as K375, K453, K503, and DWR, respectively. The treatments given included four different salts levels, of NaCl, CaCl2 and CaCO3. Each of the salt was prepared in four ECe values; 2.0dSm-1, 3.0dSm-1,4.0dSm-1, and 5.0dSm-1 in addition to 0.0dSm-1..Each of the four salt concentrations and the four cowpea cultivars were factorially combined and arranged in a split plot design established in three replicates. Variety and salt type served as main plot while salt concentration served as subplot.

Cultural practices: In both sites, a land measuring 250m2 was selected, ploughed, and ridged using a tractor. Using stick pegs, the lands were demarcated into plots and blocks. The lands were regularly watered from irrigation water in both farms. The land was prepared and used during the dry season of 2013 and 2014 between the months of February and May. Three seeds were sown after ridging by dibbling with hand deep into 5cm into the wet soil late in the evening into holes which are 25cm along the ridges. Two weeks after sowing (WAS), the seedlings were thinned to 2 plants per stand. Weeding was done using local hoes at 2 WAS and 6 WAS. Cypermethrin 10% Electic. Conductivity (E.C.). insecticide was sprayed 3,6 and 9 WAS.

Salt Application: In addition to the original salt content of the soil used, which served as control, four salt concentrations were prepared thus, obtaining five salt levels. The salts applied (which are the common salt in our soil)were NaCl, CaCO3, and CaCl2. The salt concentration was prepared to vary electrical conductivity of the soil as follows; Na+ in the form of NaCl, Ca2+ in the form of CaCO3 and Ca2+ in the form of CaCl2 were prepared in four electrical conductivity (ECe) values i. e. 2.0dSm-1 , 3.0dSm-1, 4.0dSm-1 5.0 dSm-1 respectively. The salts were weighed appropriately and dissolved in distilled water to obtain the ECe values accordingly. Salinization treatments were imposed by adding the salt solutions to the soil in each plot accordingly, monitoring with an electric conductivity metre. The salination was carried 2WAS shortly before sunset to minimize plant damage.

Data Collection: Data collected in the field experiment on rate of photosynthesis was evaluated and recorded at 4, 6, 8 and 10 WAS. Two plants in ridges 2 and 5 were randomly selected, tagged and used and data collected for growth characters. Data collected on yield and yield attributes were collected from all the plants in the two mid ridges (ridges 3 and 4) at harvest. They include; 100 seed weight, haulms weight per hectare (Kg/ha),grain yield per hectare (Kg/ha),number of pod per plant, pod yield per hectare (Kg/ha)and number of seed per pod.

Results

Effect of salinity on rate of photosynthesis

The response of the different cowpea cultivars as affected by different salts and their varying concentrations on rate of photosynthesis per plant is shown in Table 1. The salts negatively affected the rate of photosynthesis of the cowpea plant as compared with the control. Plants treated with CaCl2 appeared least retarded in most of the sampling periods. CaCO3 treatment resulted in most inhibition. Effect of concentrations of salts on the rate of photosynthesis per plant showed noticeable reversible effect, as it was observed that concentration of the salts increased rate of photosynthesis and this was reversely decreased in both sectors in all the sampling periods. The plants treated with salt level of 0.0dSm-1 produced plants with higher rate of photosynthesis value while the concentration of 5.0dSm-1 inhibited the rate of photosynthesis in most of the plants in all the sampling periods. The different varieties of cowpea responded differently. K-332, an improved variety and Dan Wuri (DWR), a local cultivar appeared least inhibited at sites treated with surface water and ground water in both 2013 and 2014.

Table 1: Effects of different salts and concentrations on rate of photosynthesis (%) per plant of varieties of Cowpea at 4, 6, and 8 WAS in field trial using surface water and ground water, 2013 and 2014

	2013							2014					
Treatment		Surface Water			Ground Water			Surface Water			Ground Water		
		6 WAS	8 WAS	10 WAS	6 WAS	8 WAS	10 WAS	6 WAS	8 WAS	10 WAS	6 WAS	8 WAS	10 WAS
Salts	Control	70.1b	73.2ab	74.5b	67.9b	69.6ab	70.7b	68.2c	72.2b	73.2a	68.2ab	68.1b	71.2a
	$CaCl_2$	71.7a	73.8a	75.2a	68.1a	69.9a	71.2a	71.7a	73.2a	70.2c	68.8a	68.1b	70.2b
	NaCl	69.4c	70.5b	72.7c	66.3c	68.1c	69.2c	68.4b	70.0c	72.1b	67.3b	69.0a	69.8c
	$CaCO_3$	68.1d	70.2c	71.4d	65.4d	67.2d	68.5d	68.4b	70.1c	71.2bc	66.4c	67.0c	66.5d
	SE ±	0.04	0.12	0.03	0.02	0.11	0.05	0.10	0.13	0.03	0.01	0.13	0.06
Concentration	0.0 dSm^{-1}	65.2b	67.7a	71.2a	64.4ab	66.2a	70.1b	69.2a	67.2a	71.0b	64.8b	68.1a	70.3b
	2.0 dSm^{-1}	64.4bc	66.2ab	70.3b	63.2bc	64.7b	71.1ab	64.9cb	67.2a	70.5b	62.8cd	64.9b	71.4a
	3.0 dSm^{-1}	63.1d	64.7c	71.1ab	67.1a	63.3bc	69.9bc	63.3c	64.8b	71.4a	67.2a	64.3c	68.9c
	4.0 dSm^{-1}	67.1a	63.3cd	68.9c	63.1c	62.1c	68.8c	67.1b	63.3b	68.9c	63.1d	62.1d	68.8c
	5.0 dSm^{-1}	62.3c	62.1d	64.8d	67.8b	61.1c	72.3a	62.5d	62.4c	68.3d	63.9c	63.9cd	62.5d
	SE ±	0.202	0.121	0.096	0.111	0.230	0.087	0.102	0.098	0.006	0.012	0.006	0.005
Variety	97K-452	67.2a	65.4a	71.1a	63.8d	63.4c	70.2d	67.3a	66.4a	71.3a	63.9c	63.6ab	70.8b
	04K-332	66.1b	64.5b	70.3b	70.2a	72.2a	71.1b	66.2b	64.4b	68.3c	70.3a	71.2a	70.1c
	98K-503	65.6ab	63.2cd	70.1c	66.5c	69.6bc	70.7c	65.3c	63.1d	70.2b	67.5b	69.1bc	70.3bc
	DWR	63.8c	63.4c	70.2b	68.1b	69.9b	71.2a	63.3d	63.6c	70.1bc	68.4ab	69.4b	71.3a
	SE ±	0.091	0.121	0.122	0.067	0.014	0.310	0.112	0.012	0.005	0.004	0.014	0.061
Interaction	Sec * Salt	NS	NS	NS	*	NS	*	NS	NS	*	NS	**	*
	Sec *Var	NS	NS	*	*	NS	NS	NS	NS	NS	*	*	*
	Salt * Var	NS	NS	*	*	NS	*	NS	*	*	NS	*	*

Means followed by the same letter(s) within the same column and treatment are not significantly different at 5% level of DMRT

LEGEND
SE ± = Standard Error (Plus, Minus)
dSm^{-1}= Deci Siemens (1/10)
WAS = Week After Sowing
DWR = Dan Wuri
$CaCl_2$ = Calcium Chloride
NaCl = Nasium Chloride
$CaCO_3$ = Calcium Carbonate
DMRT = Duncan Multiple Ranking Test
aa= Highest Value
ab = High Value
bb = Slightly high Value
bc = Lower Value
cc = Very Low Value
cd = Lowest Value
Sec = Sector (Site)
Salt= Salts
Var= Variety
NS = Not Significant
*** Very strongly Significant Interaction
** Strong Significant Interaction
* Significant Interaction

Effect of Different Salts and their Concentrations on Yield and Yield Attributes

100 seed weight: The main effect of the different salts and their varying levels on different cowpea cultivars on 100 seed weight is shown in Table 2. Salt treatment resulted in retarding effect on 100 seed weight of the cultivars of Cowpea as compared with the control. In 2013, plants treated with CaCO3 produced the lightest seeds (15.1g) when surface water was used while in plants treated with ground water, NaCl treated plants yielded the lightest seeds (15.5g). In 2014, NaCl treated plants were significantly more retarded with (15.1g) weight of 100 seeds in plants treated with surface water. In plants treated with ground water, CaCO3 treated plants yielded seeds with the lightest weight. Salinity levels showed noticeable decrease in 100 seed weight in the different treatment combinations. As the concentration of the salt increased, the 100 seed weight decreased, with the concentration of 5.0 dSm-1 inhibiting the 100 seed weight over the control. Least 100 seed weight of 15.2g was observed in plants treated with 5.0dSm-1. Variety 04K-332 produced lightest seeds in 2013 under surface water.

Haulms weight: Result obtained from the study showed that plants treated with NaCl produced the lightest haulms weighing118 kg/ha when surface water was used while in plants treated with ground water, CaCO3 treated plants produced the lightest haulms weighing115.0 kg/ha. On the other hand, in 2014, plants treated with CaCO3 produced the lightest haulms, weighing105 kg/ha when surface water was used, while in plants treated with ground water, NaCl treated plants produced the lightest haulms weighing112.9 kg/ha. Salinity levels showed noticeable decrease in haulms weight in the different treatment combinations. 5.0 dSm-1inhibited the haulms weight significantly the more as compared to the control. The least haulms weight of 102.5 kg/ha was observed in plants treated with 5.0dSm-1. Variety 98K-503 produced lightest haulms in 2013 under surface water(see Table 2).

Grain yield: Findings obtained from the study as revealed in Table 2 showed that the different salt types had negative effect on the grain yield of the cultivars of cowpea as compared with the control. In 2013, plants treated with CaCO3 produced the least grain yield of 486.5 kg/ha using surface water, while in plants treated with ground water, CaCO3 treated plants yielded the lightest grains with 476.6 kg/ha. In 2014, plants treated with CaCO3 produced lightest grains using surface water and in plants treated with ground water. Salinity levels showed significant noticeable decrease in grain yield in the different treatment combinations. Increase in salt concentration decreased grain yield significantly considerably, with the concentration of 5.0dSm-1 inhibiting the yield the most. The least grain yield (435.3 kg/ha) was observed in plants treated with 5.0dSm-1 when surface water was used in 2014. The different varieties of cowpea showed different responses to the salt treatment with variety DWR, a local cultivar consistently producing the least in all the sampling places under both surface and ground water. The interaction between sector and salts, sector and variety as well as salt and variety showed significant difference at 5% of DMRT. In 2013, the plants treated with CaCO3 produced the lowest number of pod per plant i.e. 7.2 pods per plant when surface water was used while in plants treated with ground water, CaCO3 treated plants produced the least number of pods (6.9 pods). In 2014 plants treated with CaCO3 produced least number pods in both sectors. Increased salinity levels caused noticeable decrease in number of pod per plant in the different treatment combinations.

Pod Yield: The different levels of salinity had a negative effect on pod yield of the cultivars of cowpea as shown in Table 3. In 2013, plants treated with CaCO3 produced the least grain yield of 640.4 kg/ha) when surface water was used while in plants treated with ground water, CaCO3 treated plants produced the least grain yield with634.3 kg/ha. In 2014, plants treated with CaCO3 produced the lightest grains when both surface and ground water was used. Increased levels of salinity showed significant considerable decrease in pod yield in the different treatment combinations. It was also observed that grain yield weight decreased with 5.0 dSm-1 concentration inhibiting the yield the most as compared to the control. The least pod yield of 627 kg/ha was observed in 2013 in plants treated with CaCO3. Pod yield of the different varieties showed different response to the salt treatment. 98K-503 produced the least pod yield in plants treated with surface water as well as those treated with ground water in 2013. The interaction between sector and salts, sector and variety as well as salt and variety also showed significant differenced at 5 % of DMRT.

Number of seed per pod: Results on Table 3revealed a negative effect on the number of seed per pod of the cultivars of Cowpea as compared with the control with concentration of 5.0 dSm-1 inhibiting the number of seed per plant the most. The least number of seed per plant of (54.1) was observed in 2014 in plants treated with ground water. The pod yield observed in the different varieties of cowpea showed different responses to the salt treatment. Variety 98K-503 produced the least number of seeds per pod in plants treated with both surface and ground water in 2013and 2014.

Table 2: Effects of different salt concentrations on the different varieties of cowpea plant yield and yield attributes at harvest in plants grown using surface water and ground water, field trial 2013 and 2014

		2013						2014					
Treatment		Surface Water			Ground Water			Surface Water			Ground Water		
		100 Seed Weight (g)	Haulms Weight/Ha (Kg/ha)	Grain Yld/Ha (Kg/ha)	100 Seed Weight (g)	Haulms Wgt/Ha (Kg/ha)	Grain Yld/Ha (Kg/ha)	100 Seed Weight (g)	Haulms Weight/Ha (Kg/ha)	Grain Yld/Ha (Kg/ha)	100 Seed Weight (g)	Haulms Wgt/Ha (Kg/ha)	Grain Yld/Ha (Kg/ha)
Salts	**Control**	15.7b	132.3a	622.8ab	16.1a	120.1a	589.3a	14.2c	131.8a	614.3b	16.1a	138.8a	589.3a
	$CaCl_2$	16.4a	123.7b	644.1b	15.9ab	118.8c	491.1b	15.4a	121.1ab	627.1a	15.9b	129.0b	491.1c
	NaCl	15.3bc	118.1c	564.2c	15.5c	123.3b	502.2b	15.1bc	108.8c	574.2c	15.8bc	112.9d	512.2b
	$CaCO_3$	15.1d	123.9bc	486.5d	15.8b	115.0d	476.6cd	15.2b	105.5d	496.2d	15.7c	121.8c	476.7d
	SE ±	0.321	0.441	0.239	0.257	0.098	0.065	2.09	0.07	0.02	1.09	0.98	1.11
Concentration	**0.0 dSm^{-1}**	16.1a	127.2a	589.3a	16.1b	131.1a	621.3a	16.1a	136.8a	539.1a	16.1b	131.8a	762.3a
	2.0 dSm^{-1}	15.9a	120.2ab	491.1c	16.4ac	126.8b	643.2b	15.9b	124.8b	493.1c	16.0bc	130.2b	643.2b
	3.0 dSm^{-1}	15.5d	108.0c	502.2b	15.3cd	128.2ab	561.2c	15.5cd	125.1c	501.9ab	15.3d	127.9c	561.2c
	4.0 dSm^{-1}	15.8d	110.2cd	476.6cd	15.0d	117.7c	481.1cd	15.8c	121.1cd	496.1cd	15.9c	128.1cd	489.8cd
	5.0 dSm^{-1}	15.2	102.5d	465.3d	15.4cd	112.3d	455.9d	15.2d	111.7d	435.3d	16.4a	113.8d	485.9d
	SE ±	0.003	0.300	0.002	0.034	0.070	0.016	1.09	0.67	2.22	0.12	0.99	0.08
Variety	**97K-452**	15.8a	129.6a	486.4a	15.9a	132.2a	491.1	15.8a	121.0c	486.4a	15.9a	131.9a	491.1b
	04K-332	15.2b	128.8ab	459.8b	15.7b	119.5c	503.3a	15.2c	127.1ab	459.8c	15.7b	123.1b	503.3a
	98K-503	15.4ab	117.2d	461.1c	15.3cd	120.0b	469.9c	15.4b	128.2a	461.1b	15.3c	121.0c	469.1d
	DWR	15.3c	118.4c	438.3	15.1d	113.3d	466.5d	15.4b	113.9d	408.3d	15.2d	131.9a	469.5c
	SE ±	0.020	0.007	0.021	0.025	0.210	0.103	0.23	3.33	0.38	0.89	2.23	0.17
Interaction	**Sec * Salt**	NS	NS	*	NS	NS	*	NS	NS	*	NS	NS	*
	Sec *Var	NS	NS	**	NS	NS	*	NS	NS	**	NS	NS	NS
	Salt * Var	NS	*	*	NS	*	*	NS	*	*	NS	*	*

Means followed by the same letter(s) within the same column and treatment are not significantly different at 5% level of DMRT

Table 3: Effects of different salt concentrations on the different varieties of cowpea plant yield and yield attributes at harvest in plants grown using surface water and ground water, in 2013 and 2014

Treatment		2013								2014							
		Surface Water				Ground Water				Surface Water				Ground Water			
		No of Pod/ Plant	Pod Yld/Ha (Kg/ha)	No of Seed /Pod	No of Seed / Plant	No of Pod/ Plant	Pod Yld/Ha (Kg/ha)	No of Seed /Pod	No of Seed / Plant	No of Pod/ Plant	No of Seed /Pod	No of Seed / Plant	Pod Yld/Ha (Kg/ha)	No of Pod/ Plant	No of Seed /Pod	No of Seed / Plant	Pod Yld/Ha (Kg/ha)
Salts	Control	8.2a	734.7a	8.5a	64.3a	8.2a	714.5a	7.8a	62.2a	7.8	8.2a	64.3ab	614.3c	8.3a	7.8a	62.2a	611.3c
	$CaCl_2$	8.1b	687.4b	7.2b	63.5b	7.4c	711.9b	7.1b	61.9ab	8.3	7.3b	63.6a	623.1b	7.6b	7.1b	61.9b	719.0a
	NaCl	7.5c	655.9c	6.8c	60.9c	7.5b	689.2c	6.7c	59.8c	7.8	6.3c	60.8c	654.1a	7.3bc	6.7cd	59.8c	652.2b
	$CaCO_3$	7.2d	640.4d	7.1bc	56.8d	6.9d	634.3d	6.4d	56.7d	7.3	7.0bc	57.2d	641.1ab	6.8c	6.5d	56.7d	630.3bc
	SE ±	**0.14**	**0.14**	**0.02**	**0.03**	**0.17**	**0.18**	**0.02**	**0.05**	**1.01**	**1.02**	**008**	**0.02**	**1.20**	**0.82**	**0.77**	**2.03**
Concentration	0.0 dSm^{-1}	8.0a	714.5a	7.8a	66.2a	8.3a	734.7a	8.6a	64.5a	7.9	7.4a	67.1a	724.1a	8.0ab	8.7a	64.5a	731.0a
	2.0 dSm^{-1}	7.4b	711.9ab	6.6cd	61.1bc	8.3a	687.4b	7.1b	62.1ab	7.4	6.9c	61.4c	701.9b	8.2a	7.2ab	62.3ab	687.4b
	3.0 dSm^{-1}	7.5b	689.2c	7.1c	62.1b	7.5b	655.9c	6.7d	60.9c	7.5	7.0b	62.1b	682.2c	7.5c	6.7c	60.9bc	665.9c
	4.0 dSm^{-1}	6.9d	634.3d	6.8d	61.2bc	7.2c	640.4d	7.1b	56.8cd	6.9	6.8c	61.1cd	634.3cd	7.2d	7.2a	56.7c	641.4cd
	5.0 dSm^{-1}	7.2cb	627.7d	7.8a	60.2d	7.1d	641.5d	7.0c	54.5d	7.2	7.4a	60.4d	621.9d	7.3cd	7.1b	54.1d	633.6d
	SE ±	**0.050**	**0.089**	**0.005**	**0.090**	**0.006**	**0.011**	**0.071**	**0.014**	**0.007**	**0.087**	**2.02**	**0.109**	**2.078**	**2.04**	**1.08**	**3.098**
Variety	97K-452	7.5b	655.9d	6.8c	61.2ab	8.7a	703.3a	7.7a	63.3a	7.5ab	6.9b	60.2c	605.9d	8.1b	7.8a	63.2a	713.3a
	04K-332	8.2a	740.4ab	6.4d	58.9d	8.1b	674.4ab	7.1c	62.4b	8.3a	6.5c	54.9d	741.2a	8.3a	7.2bc	62.4ab	634.6c
	98K-503	7.1d	641.5a	7.8a	62.2a	7.9c	657.5d	7.3b	60.8c	7.1c	7.7a	61.1b	641.5c	7.9c	7.4b	61.8b	657.5bc
	DWR	7.2c	714.5c	7.1b	61.9c	7.2d	667.1c	6.7d	60.2d	7.2bc	7.1ab	61.9a	714.7ab	7.1d	6.7c	60.2c	667.1b
	SE ±	**0.008**	**0.015**	**0.045**	**0.024**	**0.044**	**0.018**	**0.008**	**0.028**	**3.009**	**0.087**	**0.220**	**1.092**	**0.078**	**0.777**	**0.121**	**4.098**
Interaction	Sec * Salt	NS	NS	NS	NS	*	*	*	NS	NS	NS	NS	*	*	NS	*	*
	Sec *Var	*	*	NS	NS	*	NS	*	NS	*	NS	NS	**	NS	*	*	**
	Salt * Var	NS	*	NS	NS	*	*	NS	NS	*	*	NS	*	NS	NS	NS	*

LEGEND SE ± = Standard Error (Plus, Minus); dSm^{-1}= Deci Siemens (1/10); WAS = Week After Sowing; DWR = Dan Wuri; $CaCl_2$ = Calcium Chloride; NaCl = Nasium Chloride; $CaCO_3$ = Calcium Carbonate; DMRT = Duncan MultipleRanking Test; aa= Highest Value; ab = High Value; bb = Slightly high Value; bc = Lower Value; cc = Very Low Value; cd = Lowest Value; Sec = Sector (Site); Salt= Salts; Var= Variety; NS = Not Significant; *** Very strongly Significant Interaction; ** Strong Significant Interaction; * Significant Interaction

Discussion

Different plants including cowpea have varied ability to produce chlorophyll which directly determine their ability to photosynthesize. This research revealed the significant effects of salts studied on photosynthesis. Possibly the salts suppressed the ability of the plants to produce chlorophyll thereby reducing their ability to photosynthesize. In this research photosynthetic ability of DWR and K-332 were significantly inhibited. Gunasekera and Berkowitz (1993) reported reduction in photosynthetic enzymes, chlorophyll and carotenoids in plant growing under saline condition. This work supported the findings of Emine et al. (2010) who reported reduction in electronically measured rate of photosynthesis, leaf chlorophyll content and mineral element content of some maize (Zea mays L.) cultivars. The effect of salts and their concentrations on the plant rate of photosynthesis suggested that plants not treated with salts have improved ability to generate more chlorophyll and hence possess better ability to carry out photosynthesis as confirmed by Harrison, .(2006) who reported greater chlorophyll content and higher rate of photosynthesis in plant not treated with NaCl2 salt as compared with those treated. However, calcium salt in form of CaCO3 was observed to reduce photosynthesis more than NaCl2 confirming an investigation carried out by Francois and Mass, (1994) who reported that calcium salt suppressed rate of photosynthesis more than sodium salts in potato plants. The effect of the salts was observed to be more pronounced at old age of the plant’s growth, as more salt tend to accumulate in the plant tissue at that time. Effects of higher concentrations of the salts significantly suppressed chlorophyll formation more, confirming the work performed by Stepien and Klobus (2006) who reported decrease in chlorophyll and enzyme activities in wheat as a result of increased salts concentrations. The response of the improved varieties in overcoming salt stress became evident with time, indicating the likely hood that the plant adjusts to the salinity towards maturity.

It has long been recognized that when plants are grown under a particular set of conditions they adjust their photosynthetic capacity to match those conditions (Walters, 2005). However, not all plants succeed in this adjustment. The effect of salinity on plant net photosynthesis revealed a remarkable similarity in trend between rate of photosynthesis and yield.

Environmental stress such as salinity and temperature affects nearly every biochemical and physiological character of plants and subsequently affects yield and yield attributes (Heidarietal., 2012).

The effect of the salts particularly at high concentration on the cowpea varieties with regards to yield and yield attributes appeared to have detrimental effect on the plants. The salt types reduced the grain and pod yield of the cultivars. This observation corroborates work done by Aldoss (2010) who reported that salinity is one of the most significant problems in agriculture worldwide, negatively affecting plant growth and development and affecting more than 50% of arable land and reducing yield by at least 20%.Most known crops are sensitive to salinity and do not produce economically significant yield at high salinity levels. Plants treated with no salt showed higher values in all the yield parameters studied. On the other hand, plants treated with CaCl2significantly produced higher values in almost all the yield parameters analyzed in both sites.

Conclusion

The present study revealed that the rate of photosynthesis, yield and yield parameters were inhibited by the different concentrations of salts, particularly at higher concentrations of 4.0dSm-1 and 5.0dSm-1. CaCO3 and CaCl2 suppressed photosynthesis and yield. Local varieties of cowpea were observed to thrive significantly poorer in the saline soils than improved cultivars. Concentration 3.0dSm-1 to 4.0dSm-1, inhibited photosynthesis and yield with 5.0dSm-1 showing the greatest inhibition. Variety, IT97K-452-2 appeared to be most tolerant while Danwuri variety was the most susceptible.

It can be seen from the research work that salinity is a serious problem that require urgent attention, judging by way it decreased yield. As such, it is advisable that screening exercise in respect of salinity tolerance of other varieties of this and other crops should be carried out prior to intensive or local cultivation of the crop under irrigation farming system for optimum yield. It is equally advisable that factors responsible for increasing soil salinity should be studied and controlled to avoid the negative effect of salinity particularly as it is challenging to our food security.

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