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Amelioration of salt affected soils for cowpea growth by application of organic amendments

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Abstract
The present study is design to investigate the effect of compost and microbial inoculants on salinity stress on cowpea plants. Three different salinity levels (0.25%, 0.45%, and 0.65%) were used alone, with compost and with microbial inoculants as treatments. Coconut coir composted with *Trichoderma* sp. used as composted material. Results showed that treatments with different salinity levels alone had more severe effects on physical and biochemical parameters of experimental plants as compare with compost and microbial inoculants. Organic amendments improved the growth of plants with salinity levels.

Keywords: Salinity, Compost, Microbial inoculants, cowpea

1. Introduction

Salinity is the major problem in agricultural land. It is a major factor reducing plant growth.[1] The direct effect of salts on plant growth have three broad categories: (i) a reduction in the osmotic potential of the soil solution that reduces plant available water, (ii) a deterioration in the physical structure of the soil such that water permeability and soil aeration are diminished, and (iii) increase in the concentration of certain ions that have an inhibitory effect on plant metabolism.[2] Excess salt may affect plant growth either through osmotic inhibition of water uptake by roots or specific ion effects, which may cause direct toxicity [3, 4].

Composting is the biological decomposition and stabilization of organic substrates to produce a stable product, free of pathogens and weed seeds and can be beneficially applied to crops [5]. In composting the wastes are converted into value added products that help to increase the revenue of the farmers and industrialists since waste and the by-product of one industry can be raw material for an- other industry [6]. Coir fiber derived from coconut husks has become an increasingly popular growing media component. It is all natural, organic, and recyclable& is considered a fully "sustainable" growing media substrate. It is used as a complete, stand-alone substrate or as a component in growing media blends. It is a good carrier for microbe inoculation. It can holds moisture and nutrients to provide a greater reserve of nutrients in the substrate with less run off. Additionally, disease suppression has been demonstrated in Coir. Organic farming is one of such strategies that not only ensures food safety but also adds to the biodiversity of soil [7].

Biofertilizers keep the soil environment rich in all kinds of micro- and macro-nutrients via nitrogen fixation, phosphate and potassium solubilization or mineralization, release of plant growth regulating substances, production of antibiotics and biodegradation of organic matter in the soil [8]. The additional advantages of biofertilizers include longer shelf life causing no adverse effects to ecosystem [9]. Many tools of modern science have been extensively applied for crop improvement under stress, of which PGPRs role as bioprotectants has become paramount importance in this regard [10]. The main salinity effect on crops is inhibition of plant growth and development, and death under extreme salinity levels. Biofertilizers, interact with salinity. [11]

Cowpea is an annual legume, Important to the live food of millions of people as a vegetable. Cowpea seeds are a nutritious component in the human diet as well as a nutritious livestock feed. The protein in cowpea seeds is rich in lysine and tryptophan amino acids compared to rich in lysine and tryptophan amino acids compared to cereal seeds [12]. Cowpea is the major food legumes that serves as protein source (>25% protein in seed), and cultivated on a total area of 14 million ha world over [13].

2. Materials and Methods

Healthy, sterilized *Vigna unguiculata* seeds were sown in plastic pots with 1 kg soil. The setup was maintained as 3 conc. of saline water (0.24%, 0.44% and 0.64%) & 1 control. All the three levels of salinity were supplemented with biofertilizer (Trichoderma harzianum @ 1.5×10^{8}cfu) and compost (coconut coir @ 5g / kg soil) amendment separately and irrigated with enough water. East set was replicate thrice for statistical analysis. The setup was continued for 15 days and harvested to measure physical parameters including root length, shoot length, fresh weight, dry weight and then subjected to biochemical testing for photosynthetic pigments [14].

3. Result and discussion

Salinity is a most important abiotic factor limiting plant growth [15]. It badly affects more or less all stages of plant growth and development [16]. Stress conditions such as high temperature, low humidity and salt stress have a depressing effect on plant metabolism with a subsequent decline in crop quality and quantity [17]. The result presented in table 1 showed that as salt concentration increased the root length of experimental plants was decreased up to 36% while plants treated with compost and biofertilizer showed significant promotion in root lengths as compared to control and salt treated plants up to 80%. Organic matter (OM) can function as salt ion binding agents who detoxify the toxic ions, particularly Na^{+} and Cl^{-} [18]. Another study showed that OM application to saline paddy soil is an useful remediation method, in terms of the physical, chemical and biological properties of the soil [19], which can be used to augment the growth and development of rice crops prior to grain harvesting [20, 21].

Table1: Effects of organic amendments on root and shoot lengths of cowpea in saline soil.

S.no	Treatments	Root length (cm)	Shoot length (cm)
1	Control	7.8 ±2.58	16.22 ±8.4
2	S1 (.25% Salt)	8.8 ±4.39 (+12.82%)	13.82 ±5.4 (-16.84%)
3	S1+Compost	13.67 ^{c}±1.12 (+75.25%)	18.3 ±2.8 (+10.10%)
4	S1+Biofertilizer	9.62 ±4.18 (+23.33%)	10.46 ±2.8 (-37.06%)
5	S2 (.45% Salt)	6.1 ±2.48 (-21.79%)	8.9 ±1.73 (-46.45%)
6	S2+Compost	12.73^{d} ±0.87 (+63.20%)	19.97 ±0.71 (+20.15%)
7	S2+Biofertilizer	9.2 ±3.25 (+ 17.94%)	11.28 ±4.75 (-32.12%)
8	S3 (.65% Salt)	4.93 ±0.37 (-36.79%)	6.73 ±1.49 (-59.50%)
9	S3+Compost	14.22 ^{c}±0.49 (+82.30%)	12.63 ±3.14 (-24.00%)
10	S3+Biofertilizer	14.16 ^{c}±1.93 (+81.53%)	8.78 ±4.73 (-47.17%)

Each value is the mean ± S.D (standard deviation) of 3 replicates. Means bearing superscripts in each column are significantly different with respective control at p<0.05(LSD). Values with in parenthesis represent precent increase or decrease (-) with respective control.

All the salinity levels (Table 1) decreases shoot lengths of experimental plants as shown in table 1 from 16-80% as salinity level increased. Salinity induced decline in overall growth might be an indication of endogenous hormonal imbalance [22]. Growth decline due to salinity is mostly recognized to water scarcity due to lowered water potential in root medium, nutritional imbalance and specific ion toxicity arising from higher concentration of Na+ and Cl- [16]. When plants treated with coir compost and biofertilizer along with three salinity levels the effect of salinity decreased non significantly (Table 1). Previous studies have confirmed that soil physical, chemical and biological properties in salt-affected areas are strongly enhanced upon the application of organic manure, leading to better crop growth and development [19].

Table 2: Effects of organic amendments on root and shoot lengths of cowpea in saline soil.

S.no	Treatments	Fresh weight (g)	Dry weight (g)
1	Control	3.56 ±3.1	0.2 ±0.08
2	S1 (.25% Salt)	5.9 ±7.19 +65.73%	0.15 ±0.03 -25%
3	S1+Compost	5.94 ±7.8 +66.85%	0.25 ±0.05 +18%
4	S1+Biofertilizer	4.86 ±5.8 +36.51%	0.17 ±0.03 -15%
5	S2 (.45% Salt)	1.`13 ±0.15 -68.25%	0.13 ±0.03 -35%
6	S2+Compost	8.02 ±10.9 +125.28%	0.24 ±0.03 +20%
7	S2+Biofertilizer	2.99 ±2.5 -16.01%	0.21 ±0.01 +5%
8	S3 (.65% Salt)	0.95 ±0.10 -73.31%	0.12 ±0.06 -40%
9	S3+Compost	4.01 ±5.89 +12.64%	0.17 ±0.05 -15%
10	S3+Biofertilizer	3.36 ±3.3 -5.61%	0.14 ± 0.02 -30%

Each value is the mean ± S.D (standard deviation) of 3 replicates. Means bearing superscripts in each column are significantly different with respective control at p<0.05(LSD). Values with in parenthesis represent precent increase or decrease (-) with respective control.

Effect of different level of salinity (Table 2) on fresh and dry weights of experimental plants also negative and reduced fresh weights up to 73% and dry weights up to 40% as salinity increased but when treated with compost and biofertilizer the effects of various salinity levels become reduced as shown in table 2. The effects of salinity were determined at seedling stage of wheat range from drop in germination percentage, fresh and dry weight of shoots and roots to the uptake of a mixture of nutrient ions [23]. Our results are in harmony with former studies reporting growth decline in salt stressed legume plants, particularly cowpea. [24, 25, 26].

Table 3: Effects of organic amendments on root and shoot lengths of cowpea in saline soil.

S.no	Treatments	Chl-a (mg/g fresh wt.)		Chl-b (mg/g fresh wt.)		T.Chl (mg/g fresh wt.)	
1	Control	1.23 ±0.17		1.6 ±0.14		1.96 ±0.36	
2	S1 (.25% Salt)	1.5 ±0.05	+21.95%	1.09 ±0.51	-31.87%	1.58 ±0.15	-19.38%
3	S1+Compost	1.83^{c} ±0.34	+48.78%	2.37 ±0.12	+46.25%	2.46^{d} ±0.50	+25.51%
4	S1+Biofertilizer	1.63 ±0.21	+32.52%	1.38 ±0.10	-13.75%	2.16 ±1.04	+10.20%
5	S2 (.45% Salt)	0.85 ± 0.10	-30.89%	0.7 ±0.12	-56.25%	1.05 ±0.52	-46.42%
6	S2+Compost	1.42 ±0.27	+15.44%	1.06 ±0.36	-33.75%	2.48^{d} ±0.64	+26.53%
7	S2+Biofertilizer	1.9 ^{c}±0.33	+54.47%	1.17 ±0.47	-26.87%	3.07^{c} ±0.51	+56.63%
8	S3 (.65% Salt)	0.63 ±0.37	-48.78%	0.57 ±0.14	-64.37%	.98 ±0.10	-50.00%
9	S3+Compost	0.88 ±0.45	-28.45%	0.76 ±0.10	-52.5%	2.07 ±0.13	+5.61%
10	S3+Biofertilizer	1.21 ±0.15	-1.62%	0.5 ±0.17	-68.75%	2 ±0.10	+2.04%

Each value is the mean ± S.D (standard deviation) of 3 replicates. Means bearing superscripts in each column are significantly different with respective control at p<0.05(LSD). Values with in parenthesis represent precent increase or decrease (-) with respective control.

Low salinity level (.25%) enhanced Chl-a concentration up to 21% in experimental plants while remaining two levels (.45% and .65%) decreased Chl-a concentration up to 48%. Application of compost and biofertilizer promote Chl-a concentration when plants exposed to .25% and .45% salinity lavels up to 48-54% (Table 3). When treated with .65% salinity the application of compost and biofertilizer only reduced the effect of salinity on Chl-a concentration. Same results were observed in Chl-b concentration in plants (Table 3). Plants experience to salt stress results in degradation of photosynthetic pigments, damage of chloroplast [13]. As concentration of salt increased in soil the amount of total chlorophyll was decreased in experimental plants (Table 3). Declining the quantity of photosynthetic pigments is one of the effects of salt stress in plants and has been reported in many crop species, the falling in chlorophylls in salinized plants could be endorsed to improved activity of the chlorophyll-degrading enzyme, chlorophyllase [4]. Effect of these given salinity treatments were reduced by the application of coir compost and biofertilizer and significantly increased total chlorophyll content in experimental plants. The favorable effects of *Trichoderma* as biofertilizer on abiotic stress have been well recognized [27, 28], while the mechanisms controlling multiple plant stress factors are still unknown. Recently, Mastouri *et al.* [29] reported that the management of tomato seeds with *T. harzianum* speed up seed germination, increases seedling vigor and ameliorates water, osmotic, salinity, chilling and heat stresses by inducing physiological defense in plants against oxidative damage. A general mechanism through which beneficial fungi and PGPR boost plant tolerance to these abiotic stresses could be the amelioration of damage caused by (reactive oxygen species) ROS accumulation in stressed plants [29].

4. Conclusion
Salinity decreases plant growth through osmotic effects and reduces the water uptake, thus causing a decline in growth. The physical, chemical and biological properties of soil in salt-affected areas are enhanced by the use of Organic manure and biofertilizer leading to improved plant growth and development.

5. References

1 Batool N, Shahzad A, Ilyas N, Noor T. Plants and Salt stress. Intl J Agri Crop Sci 2014; 7(9):582-589.

2 Nishma K S, Adrisyanti B, Anusha SH, Rupali P, Sneha K, Jayamohan NS *et al*. Induced growth promotion under *in vitro* salt stress tolerance on *solanum lycopersicum* by fluorescent pseudomonads associated with rhizosphere. Int. Journal of Applied Sciences and Engineering Research, 2014; 3(2):422-430.

3 Saqib ZA, Akhtar j, Ul-Haq MA, Ahmad I. Salt induced changes in leaf phenology of wheat plants are regulated by accumulation and distribution pattern of Na+ ion. Pak. J. Agri. Sci 2012; 49:141-148.

4 Abbas SM, Akladious SA. Application of carrot root extract induced salinity tolerance in cowpea (Vigna sinensis L.) seedlings. Pak. J. Bot 2013; 45(3):795-806.

5 Sunar NM, Stentiford EI, Stewart DI, Fletcher LA. The Process and Pathogen Behaviour in Composting: A Review. Proceeding UMT-MSD 2009 Post Graduate Seminar Universiti Malaysia Terengganu, Malaysian Student Department UK & Institute for Transport Studies University of Leeds. ISBN: 2009; 978-967-(5366-04-8):78-87;

6 Ezeonu CS, Tagbo R, Anike EN, Oje OA, Onwurah INE. Biotechnological Tools for Environmental Sustainability: Prospects and Challenges for Environments in Nigeria—A Standard Review .Biotechnology Research International Article ID 450802, 2012, 1-26.

7 Megali L, Glauser G, Rasmann S. Fertilization with beneficial microorganisms decreases tomato defenses against insect pests. Agron Sustain Dev doi:10.1007/s13593-013-0187-0, 2013.

8 Sinha RK, Valani D, Chauhan K, Agarwal S. Embarking on a second green revolution for sustainable agriculture by vermiculture biotechnology using earthworms: reviving the dreams of Sir Charles Darwin. Int J Agric Health Saf 2014; 1:50–64.

9 Sahoo RK, Ansari MW, Pradhan M, Dangar TK, Mohanty S, Tuteja N. Phenotypic and molecular characterization of efficient native Azospirillum strains from rice fields for crop improvement. Protoplasma doi: 10.1007/s00709-013-0607-7, 2014.

10 Yang JW, Kloepper JW, Ryu CM. Rhizosphere bacteria help plants tolerate abiotic stress. Trends Plant Sci 2009; 14:1–4.

11 Plaut Z, Edelstein M, Ben-Hur M. Overcoming Salinity Barriers to Crop Production Using Traditional Methods. Critical Reviews in Plant Sciences 2013; 32:250–291.

12 Gad N, Mohammed MA, Bekbayeva LK. Response of Cowpea (Vigna Anguiculata) to Cobalt Nutrition. Middle East Journal of Scientific Research 2013; 14(2):177-184.

13 Cha-um S, Batin CB, Samphumphung T, Kidmanee C. Physio-morphological changes of cowpea (*Vigna unguiculata*Walp.) and jack bean (*Canavaliaensiformis*(L.) DC.) in responses to soil salinity. AJCS 2013; 7(13):2128-2135.

14 Arnon D. Estimation of Total chlorophyll. Plant Physiology 1949; 24(1):1–15.
15 Abdallah, NA, Moses V, Prakash CS. The impact of possible climate changes on developing countries, GM Crops & Food: Biotechnology in Agriculture and the Food Chain 2014; 5(2):77-80. DOI: 10.4161/gmcr.32208
16 Eisa SS, Ibrahim AM, Khafaga HS, Shehata, SA. Alleviation of Adverse Effects of Salt Stress on Sugar Beet by Pre-Sowing Seed Treatments. Journal of Applied Sciences Research 2012; 8(2):799-806.
17 Hafez MR, Soubeih KAA. Effect of mineral acids and some soil amendments on eggplant (*Solanummelongena*L.) productivity under saline soil conditions."Research Journal of Agriculture and Biological Sciences, 2012; 8(5):411-419.
18 Eletr WMT, Ghazal FM, Mahmoud AA, Yossef GH. Responses of Wheat – Rice Cropping System to Cyanobacteria Inoculation and Different Soil Conditioners Sources under Saline Soil. Nature and Science 2013; 11(10):118-129.
19 Wong VNL, Dalal RC, Greene RSB. Carbon dynamics of sodic and saline soil following gypsum and organic material additions: A laboratory incubation. Appl Soil Ecol. 2009; 41:29-40.
20 Ghafoor A, Murtaza G, Ahmad B, Boers TM. Evaluation of amelioration treatments and economic aspects of using saline-sodic water for rice and wheat production on salt-affected soils under arid land conditions. Irrigation and Drainage 2008; 57:424-434.
21 Murtaza G, Ghafoor A, Owens G, Qadir M, Kahlon Z. Environmental and economic benefits of saline-sodic soil reclamation using low-quality water and soil amendments in conjunction with a rice-wheat cropping system. Journal of Agronomy and Crops Science 2009; 195:124-136.
22 Iqbal M, Ashraf M. Changes in Hormonal Balance: A Possible Mechanism of Pre-Sowing Chilling-Induced Salt Tolerance in Spring Wheat. J. Agron. And Crop Sci 2010; 196:440-445.
23 Afzal I, Basara SMA, Faooq M, Nawaz A. Alleviation of saslilnity stress in spring wheat by hormonal priming with ABA, salicylic acid and ascorbic acid. *Int. J. Agric. Biol*. 2006; 8:23-28.
24 Wilson C, Liu S, Lesch SM, Suarez DL. Growth response of major USA cowpea cultivars. II. Effect of salinity on leaf gas exchange. Plant Sci 2006 170:1095-1101.
25 Maia JM, Macedo CEC de, Voigt EL, Freitas JBS, Silveira JAG. Antioxidative enzymatic protection in leaves of two contrasting cowpea cultivars under salinity. Biol Plant 2010; 54:159-163.
26 Patel PR, Kajal SS, Patel VR, Patel VJ, Khristi SM. Impact of salt stress on nutrient uptake and growth of cowpea. Brazilian J Plant Physiol 2010; 22:43-48.
27 Donoso EP, Bustamante RO, Carú, M, Niemeyer HM. Water deficit as a driver of the mutualistic relationship between the fungus *Trichoderma harzianum* and two wheat genotypes. Appl Environ Microbiol 2008; 74:1412-1417.
28 Bae H, Sicher RC, Kim MS, Kim SH, Strem MD, Melnick RL *et al*. The beneficial endophyte *Trichoderma hamatum* isolate DIS 219b promotes growth and delays the onset of the drought response in*Theobroma cacao*. J Exp Bot 2009; 60:3279-3295.
29 Mastouri, F, Björkman T, Harman, GE. Seed treatment with Trichoderma harzianum alleviates biotic, abiotic, and physiological stresses in germinating seeds and seedlings. Phytopathology 2010; 100:1213-1221.