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Kiran Doodhawal
Department of Soil Science and Agricultural Chemistry, S.K.N. Agriculture University, Jobner, Rajasthan, India

BL Yadav
Department of Soil Science and Agricultural Chemistry, S.K.N. Agriculture University, Jobner, Rajasthan, India

Hansa Baradwal
Department of Soil Science and Agricultural Chemistry, Bundelkhand University, Jhansi, Utter Pradesh, India

Jitendra Singh Bamboriya
Department of Soil Science and Agricultural Chemistry, S.K.N. Agriculture University, Jobner, Rajasthan, India

Sushila Aechra
Department of Soil Science and Agricultural Chemistry, S.K.N. Agriculture University, Jobner, Rajasthan, India

Abhitej Singh Shekhawat
Department of Soil Science and Agricultural Chemistry, Rajasthan College of Agriculture, MPUAT, Udaipur, Rajasthan, India

Corresponding Author:
Kiran Doodhawal
Department of Soil Science and Agricultural Chemistry, S.K.N. Agriculture University, Jobner, Rajasthan, India

Impact of soil sodicity and iron fertilization on quality and ionic composition of cowpea grown in semi arid eastern plain zone of Rajasthan

Kiran Doodhawal, BL Yadav, Hansa Baradwal, Jitendra Singh Bamboriya, Sushila Aechra and Abhitej Singh Shekhawat

Abstract
A pot experiment was conducted in *kharif* season during 2016 at S.K.N. College of Agriculture, Jobner, to study the effect of different levels of sodium absorption ratio and iron on ionic composition in cowpea. Four levels of each sodium adsorption ratio (SAR) 10, 15, 20, 25 and iron (Fe) control, 5, 10 and 15 kg/ha were tested in completely randomized design with three replications. The result indicate that higher Na content, Na/Ca, Na/K, Na+K/Ca and lower Ca, Mg, K content and Ca/Mg ratio in grain and straw of cowpea was noted with increasing level of SAR. Application of Fe narrowed down the Na content, Na/K, Na+K/Ca and Na/Ca ratio in seed and straw significantly, while it increase the Ca, Mg, K content and Ca/Mg ratio in seed and straw. Among the treatment combinations, combined application of SAR 15 with Fe (@ 20 $FeSo_4.7H_2O$) proved superior in all these parameters over other treatments.

Keywords: Cowpea, Iron, SAR, Sodicity tolerance, ionic composition

Introduction
Grain legumes (also known as pulses) are important place in global food and nutrition security, as they are main sources of protein and energy for human. Pulses are not only rich source of proteins but also in other nutrients such as starch, oil, vitamin, and minerals (Katoch, 2013). Among the pulses, cowpea is the most important crop because of its multiple uses, short duration and high yielding capacity that can be planted in arid and semiarid region. Although soil salinity and sodicity are prevalent problems in arid and semiarid regions, it has been found in all the climatic zones (Munns, 2008). Salt affected soils are generally categorized as saline, sodic and saline-sodic. Sodium adsorption ration (SAR) is a widely used index for measuring soil sodicity which describes the proportion of sodium to calcium and magnesium in soil solution (Munns, 2008). Exchangeable sodium percentage (ESP) characterizes the sodicity of soils only, whereas, SAR is applicable to both soil and soil solution or irrigation water (Horneck *et al.*, 2007) [4].

These salt affected soils are not only reduced the cowpea yield but also inhibit the ionic behaviour, content and ratio in seed and straw of cowpea. Therefore, within the plant, increase the concentration of soluble salts and its responsible to cause hyper osmolality, ion toxicity and disequilibrium of nutrients that adversely affect plant growth and development (Munns, 2008). These higher levels of soluble salt concentration in plants also inhibit the other ionic concentration in plants and plant loss their salt stress tolerance mechanism due to imbalance of ionic concentration.

Iron (Fe) is an considered essential micronutrient for plants and for humans, and it is a constituent of a number of important macromolecules, including those involved in respiration, photosynthesis, DNA synthesis & metabolism and also maintain the physiochemical and biochemical processes (Briat, 2011). Plants obtain Fe from the soil, its availability poor in soil and plant showed deficiency when soil pH is at neutral or alkaline (Gómez-Galera *et al.*, 2010, Rao and Rao 1994) [12]. There are estimates that around 3 billion people worldwide are affected by Fe deficiency; this deficiency is known to be particularly common in populations that depend on staple crops as the primary food and have little or no access to animal products (White and Broadley, 2005). The conductance of such experiments has resulted in a substantial increase in salt tolerance mechanism of many crops grown under saline/sodic conditions (Ashraf, 2009 and Cha-um. *et al.*, 2011). Exogenous application of inorganic essential nutrients as foliar spray or soil has also been reported to be an economical and efficient means of mitigating the adverse effects of salt stress on different crops (Ashraf, 2009 and Kaya *et al*., 2010) of different essential nutrients play vital roles in plant growth and regulate various metabolic reactions Therefore this study was carried out to evaluate the effects of iron levels on ionic composition of cowpea under different soil sodicity levels.

Materials and methods

A pot experiment was conducted in cage house at Department of Plant Physiology, SKN College of Agriculture, Jobner, Rajasthan, India during 2016. The textural composition of experimental soil having coarse sand 35.6, fine sand 45.5, silt 10.2 and clay 07.9% and soil was loamy sand in texture with bulk density is 1.50 Mg m^{-3} and particle density is 2.60 Mg m^{-3}. The soil alkaline in reaction (pH 8.4), low in organic carbon (1.85 g/kg) and available nitrogen (128 kg/ha), medium in available phosphorus (16 kg P_2O_5 ha^{-1}), potassium (146 kg K_2O ha^{-1}) content and DTPA extractable iron (DTPA-Fe) is 4.8 ppm. The soil cationic and anionic composition of Na^+, Ca, Mg, CO_3^-, HCO_3, SO_4^{-2}, Cl^-, CEC, exchangeable Na and ESP were mentioned in table 1.

The experiment was laid out in completely randomized design with three replication and its composed with four levels of SAR viz. 10, 15, 20, 25 and iron viz. 0 (control), 2.5, 5.0 and 7.5 mg Fe kg^{-1} soil as $FeSO_4.7H_2O$, i.e. 0, 5, 10 and 15 kg Fe ha^{-1}, respectively. To attain level of SAR at 10, 15, 20 and 25, salts were added in soil like NaCl, Na_2SO_4, $NaHCO_3$, Na_2CO_3, $CaCl_2$ and $MgCl_2$ in different combinations and measured Na^+, Ca^{+2}, Mg^{+2}, CO_3^{-2}, $HCO_3^{-1,}$ SO_4^{-2} and Cl^- after treatment in soil (Table 2).

Cylindrical ceramic pots (20 cm diameter and 28 cm height) were used for sowing of crop seed and these pots were filled with 10 kg of soil (sieved with 2 mm sieve) taking care of proper drainage. The cowpea cv. 'RC-19' was sown on 12th July, 2016 with 10 seeds pot^{-1}. After germination of seeds, number of plants pot^{-1} was maintained. The crop was harvested on 25th September, 2016. The five plants from each pot were harvested at maturity and kept on threshing floor for sun drying. After complete sun drying

Chlorophyll content in leaves (mg g^{-1})

The chlorophyll content in leaves at 45 DAS was determined as per the method advocated by Arnon (1949) by taking 50 mg fresh leaves; samples were homogenized in 80 per cent acetone and aliquat was centrifuged for 10 minutes at 2000 rpm and the final volume was made to 10 ml. Absorbance of clear supernatant liquid was measured at 652 nm on spectronic-20.

$$\text{Total chlorophyll (mg g}^{-1}) = \frac{\text{A (652) x 29 x Total volume (ml)}}{\text{a x 1000 x weight of sample}}$$

Where, a is the path length = 1 cm

Protein content

The protein content in grain of maize is related to its nitrogen content (A.O.A.C., 1960) [1]. It is calculated by the following formula:

Protein content (%) = N content x 6.25

Analysis of nutrient content in plant parts

For Ndetermination, plant and grain samples were collectedseparately, oven dried and grounded in a grinder. Similarly, grain samples were collected, ground and both the samplesseparately digested by concentrated H2SO4 using digestiontablets in digestion block and total N was determined using N Auto Analyzer. For P and K determination, One gramground plant sample was transferred into a 100 ml conical flask and digested with 20 ml tri-acid mixture (10:1:4 : HNO_3: H_2SO_4 : $HClO_4$) and flask was heated slowly. After the initialreaction was completed and brown fumes ceased to evolve,heat was increased and heating was continued till theoxidation was completed *i.e.* material becomes transparentand white fumes evolve and remain within the flask.After cooling, content was filtered into volumetricflask by washing the conical flask with water and volumewas made 100 ml. K was directly measured in flame photometer and after color development, P content in plantparts were measured in spectrophotometer at 420 nm. ForFe content digested plant material was measured in AAS.

Statistical analysis

The experimental data were analyzed statistically by using analysis of variance (ANOVA) technique to Completely Randomized Design (CRD) with three replications (Gomez and Gomez, 1984). The critical difference (CD) at 5 per cent level was computed for analysis significant level of treatments.

Results and discussions

Effect of SAR

The soil sodicity levels significantly influence to ion content and its ratio in seed and straw of cowpea. The increasing levels of SAR (Sodium absorption ratio) of soil significantly decreased the Ca, Mg, K content and Ca/Mg ratio as compared to S_{10} (normal soil). The per cent decrease in Ca content in grain was found to be 7.1, 15.5 and 23.8 per cent and in straw, it was 15.9, 24.9 and 43.0 per cent under S_{15}, S_{20} and S_{25}, respectively over to S_{10} (normal soil). The extent of decrease in Mg content was found to be 6.5, 10.7 and 17.9 per cent in grain and 7.6, 17.4 and 26.1 per cent in straw under S_{15}, S_{20} and S_{25}, respectively over to S_{10}. There was a significant decrease in K content in grain and straw with increasing levels of SAR of soil. The per cent decrease in K content in grain was 6.4, 13.8 and 22.3 and 6.6 and 12.7 and 19.2 in straw due to S_{15}, S_{20} and S_{25}, respectively over control S_{10}. The effect of SAR of soil on Ca/Mg ratio was found significant and level S_{25} decreased the Ca/Mg ratio significantly over S_{10}.

The significantly increase in Na content, Na/K, Na+K/Ca and Na/Ca ratio in grain and straw with increasing level of SAR of soil. The per cent increase in Na content was observed to be 20.2, 32.6 and 45.7 in grain and 11.0, 28.4 and 42.7 in straw under S_{15}, S_{20} and S_{25}, respectively over S_{10}. The per cent increase in Na/K ratio was 25.3, 41.6 and 57.7 in grain and 16.9, 37.6 and 53.7 in straw under S_{15}, S_{20} and S_{25} as compared to S_{10}. The maximum Na+K/Ca ratio in grain (4.97) and straw (8.50) was obtained under S_{25}, while, minimum under S_{10}. The per cent increase in Na/Ca ratio was 25.9, 42.8 and 58.5 in grain and 25.1, 46.2 and 67.3 in straw under S_{15}, S_{20} and S_{25} over to S_{10}.

Specific accumulation of Na in plant tissue is toxic causing growth inhibition of plants resulted into low cytoplasmic Na^+ concentration is important for many plants growing in Na^+ affected environments. Plants cells maintain a low cytosolic Na^+ concentration presumably through Na^+ exclusion and extrusion or compartmentation inspite of higher accumulation (Nui *et al*., 1995) [9]. Cowpea presumably adopted some physiological mechanisms to restrict physiological interference of excess uptake resulting in economic growth performance in sodic environment. Similar observation has also been reported by Patra *et al*., (2002) [11] in isabgol.

Effect of Iron

Application of iron significantly increased ionic content in seed and straw of cowpea except Na. The maximum Ca content was observed under Fe_{15}, while, minimum under control Fe_0. The extent of increase in Ca content in grain was found to be 8.0, 15.1 and 21.9 per cent and 13.2, 24.1 and 33.2 per cent in straw under Fe_5, Fe_{10} and Fe_{15}, treatments, respectively over control (Fe_0). The Mg content increased in seed 3.4, 7.7 and 14.4 per cent and straw 11.7, 18.1 and 26.4 per cent under Fe_5, Fe_{10} and Fe_{15} levels of iron as compared to control Fe_0. The maximum K content both in grain and straw was found under Fe_{15}, while, minimum under Fe_0. The application of iron increased the K content in grain was 9.1, 16.5 and 22.4 per cent and in straw it was 7.1, 13.1 and 19.4 per cent due to application of Fe_5, Fe_{10} and Fe_{15}, respectively over to control (Fe_0). Na content in seed and straw decreased with increasing levels of iron. The per cent decrease in Na content was 7.9, 14.3 and 23.2 in grain and 15.7, 19.6 and 35.1 in straw under treatment Fe_5, Fe_{10} and Fe_{15}, respectively over the control (Fe_0).

The entire ionic ratio in seed and straw of cowpea decrease significantly with increasing level of iron except Ca/Mg ratio (Table 4). The per cent decrease in Na/K ratio in comparison to the control (Fe_0) was found to be 16.2, 28.5 40.4 in grain and 21.7, 30.3 and 47.8 in straw under Fe_5, Fe_{10} and Fe_{15}, respectively. There was a significant decrease in Na+K/Ca ratio in grain with increasing levels of iron as compared to control. The Maximum and minimum ratios in grain and straw was recorded Fe_0 and Fe_{15}, level. The per cent decrease in Na/Ca ratio in comparison to control (Fe_0) was found to be 15.2, 27.1 and 40.0 in grain and 26.9, 38.9 and 56.6 in straw under Fe_5, Fe_{10} and Fe_{15}, respectively.

Discussion

As stated earlier, the application of higher SAR increased the concentration of Na consequently Na may inhibit the radial movement of Ca and Mg from the external solution to the root xylem by screening of cation exchange sites in the apoplast (Lynch and Lauchli, 1985) [7]. High level of Na may adversely affect the nutritional status of plants by interfering with absorption and translocation of Ca^{2+} and Mg^{2+} resulting in salt toxicity caused by high Na/Ca and Ca/Mg ratios. The higher Na/Ca and lower Ca/Mg ratio at higher levels of SAR of soil showed more tolerance to sodicity. The results are also supported with the findings of Pathan (2001) [10], Naga *et al.*, (2013) [8] and Jakhar *et al*., (2016) [5], who reported higher Na/Ca and lower Ca/Mg ratio in grain and straw of wheat with increasing sodicity in soil. The Na/K and Na+K/Ca ratios in grain and straw of cowpea increased significantly with increasing level of SAR of soil. This may be due to the fact that Na concentration increased with the increase in alkalinity, while the K, Mg and Ca concentration deceased in soil as well as in grain and straw. Sodicity tolerance was generally associated with efficient K regulation in shoot. The results find support from the work of Pathan (2001) [10] and Kumawat and Yadav (2011) [6] who observed increased Na/K and Na+K/Ca ratios in grain and straw of soybean with increasing level of SAR of soil.

Application of Fe narrowed down the Na/K, Na+K/Ca and Na/Ca ratio in seed and straw significantly, while it increase the Ca/Mg ratio in seed and straw, (Table 4). Thus, the application of Fe also played a beneficial role to overcome the adverse effect of different SAR and held in induced the sodicity tolerance. The favourable influence of applied Fe on growth and yield as well as on mineral composition in seed and straw might be due to its catalytic effect on most of the physiological and metabolic process in plant.

The increase in Ca/Mg ratio was due to increased availability of Ca and Mg, while, concentration of Na decreased and K increased with increasing levels of iron which is responsible for decrease in Na/K Na/Ca ratio, and Na+K/Ca ratio in grain and straw. Fe application also played beneficial role to overcome the adverse effect of different SAR and helped in the inducement of sodicity tolerance. The favourable influenced of applied Fe on growth and yield as well as on nutrient concentration in grain and straw might be due to its catalytic effect on most of the physiological and metabolic process of plants. Fe is related to vitamins and helps in Cu, Zn, Mn and Mg metabolism. Therefore, its stimulatory effect on most of the physiological and metabolic process of plant might have helped in nutrient absorption from the soil in plant parts. Fe application reduced the Na/K, Na/Ca, Na+K/Ca ratio in grain and straw which could be due to the fact that concentration of Fe increased with increase in the uptake and translocation of K^+ and Ca^{2+} from root to upper parts of plants. Fe concentration decrease the concentration of Na^+ in plant parts included grain which results in less regulation of Na^+ in plant parts and grain and straw that's why more regulation of K^+ caused significant reduction in Na/K, Na/Ca, Na+K/Ca ratios and induce the tolerance character in crop to sodicity of irrigation water. It can be suggested that application of $FeSO_4.7H_2O$ reduced the Na/K, Na/Ca ratios and ionic regulation index for Na ratios which is an important character in validation of sodicity tolerance. Similar findings were also reported by Naga *et al.* (2013) [8] and Jakhar *et al*. (2016) [5].

Table 1: Ionic composition of soil

SAR	mmol/l							EC dS/m
	Na^+	Ca^{2+}	Mg^{2+}	CO_3^{2-}	HCO_3^-	Cl^-	SO_4^{2-}	
S_{10} (Control)	11.0	1.2	1.2	1.00	3.55	6.15	2.65	1.31
S_{15}	31.0	4.5	4.5	1.00	5.00	30.00	4.00	4.00
S_{20}	34.0	3.0	3.0	1.00	5.00	30.00	4.00	4.00
S_{25}	36.0	2.0	2.0	1.00	5.00	30.00	4.00	4.00

Table 2: Amount of salts added in soil (mg kg^{-1} of soil)

SAR	NaCl	Na_2SO_4	$NaHCO_3$	Na_2CO_3	K_2SO_4	$MgCl_2$	$CaCl_2$
10 (Control)	936.0	568.0	270.0	53.0	34.8	332.5	388.5
15	1404.0	568.0	270.0	53.0	34.8	213.8	249.8
20	1404.0	568.0	270.0	53.0	34.8	142.5	166.5
25	1521.0	568.0	270.0	53.0	34.8	142.5	166.5

Table 3: Effect of soil sodicity and iron levels on total chlorophyll content in leaves at 45 days and protein content.

Treatments	Total chlorophyll content (mg/g)	Protein Content (%)	
		Grain	Straw
Soil sodicity (SAR)			
S_{10}	3.86	12.93	7.93
S_{15}	3.58	13.56	8.31
S_{20}	3.28	15.25	9.50
S_{25}	3.01	16.37	10.18
SEm±	0.08	0.31	0.18
CD (p= 0.05)	0.23	0.93	0.62
Iron levels			
Fe_0 (control)	3.05	1.27	7.93
Fe_5 (5 kg Fe/ha)	3.29	1.38	8.62
Fe_{10} (10 kg Fe/ha)	3.55	1.5	9.37
Fe_{15} (15 kg Fe/ha)	3.84	1.6	10.00
SEm±	0.08	0.31	0.18
CD (p= 0.05)	0.23	0.93	0.62

Table 4: Effect of soil sodicity and iron levels on Ca, Mg, K and Na content in grain and straw.

Treatments	Ca (%)		Mg (%)		K (%)		Na (%)	
	Grain	Straw	Grain	Straw	Grain	Straw	Grain	Straw
Soil sodicity (SAR)								
S_{10}	0.252	0.465	0.168	0.092	0.799	1.815	0.178	0.421
S_{15}	0.234	0.391	0.157	0.085	0.748	1.696	0.223	0.473
S_{20}	0.213	0.349	0.150	0.076	0.689	1.584	0.264	0.588
S_{25}	0.192	0.265	0.138	0.068	0.621	1.467	0.328	0.735
SEm±	0.005	0.008	0.003	0.002	0.017	0.037	0.006	0.013
CD (P= 0.05)	0.014	0.024	0.010	0.005	0.048	0.108	0.017	0.038
Iron levels								
Fe_0	0.196	0.296	0.143	0.068	0.623	1.469	0.280	0.673
Fe_5	0.213	0.341	0.148	0.077	0.685	1.581	0.258	0.567
Fe_{10}	0.231	0.390	0.155	0.083	0.746	1.691	0.240	0.541
Fe_{15}	0.251	0.443	0.167	0.093	0.803	1.822	0.215	0.437
SEm±	0.005	0.008	0.003	0.002	0.017	0.037	0.006	0.013
CD (P= 0.05)	0.014	0.024	0.010	0.005	0.048	0.108	0.017	0.038

Table 5: Effect of soil sodicity and iron levels on Ca/Mg, Na/K,Na+K/Caand Na/Ca, ratio in grain and straw

Treatments	Ca/ Mg		Na/K		Na+K/Ca		Na/ Ca	
	Grain	Straw	Grain	Straw	Grain	Straw	Grain	Straw
Soil sodicity (SAR)								
S_{10}	1.497	5.034	0.227	0.236	3.890	4.892	0.720	0.947
S_{15}	1.488	4.581	0.304	0.284	4.167	5.650	0.972	1.265
S_{20}	1.417	4.574	0.389	0.378	4.493	6.350	1.259	1.762
S_{25}	1.389	3.881	0.537	0.510	4.970	8.497	1.736	2.901
SEm±	0.032	0.101	0.009	0.009	0.099	0.150	0.029	0.047
CD (P= 0.05)	0.093	0.291	0.026	0.025	0.286	0.434	0.084	0.136
Iron levels								
Fe_0	1.368	4.312	0.463	0.469	4.657	7.568	1.476	2.477
Fe_5	1.436	4.386	0.388	0.367	4.470	6.568	1.252	1.812
Fe_{10}	1.487	4.654	0.331	0.327	4.306	5.959	1.074	1.512
Fe_{15}	1.500	4.718	0.276	0.245	4.087	5.294	0.885	1.075
SEm±	0.032	0.101	0.009	0.009	0.099	0.150	0.029	0.047
CD (P= 0.05)	0.093	0.291	0.026	0.025	0.286	0.434	0.084	0.136

Conclusions

The lower sodium absorption ratio is beneficial for crops to maintaining adequate ionic balance and salt tolerance mechanism. Application of Fe narrowed the ionic ratios in grain and straw and mitigates the adverse effect of sodicity of soil by inducing tolerance of sodicity in the crop.

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References
1. AOAC. Association of Official Agricultural Chemists. Official Methods of Analysis. 8thEducation Association Official Agricultural Chemists. Washington. D.C, 1960.
2. Arnon DI. Copper enzymes in isolated chloroplasts, polyphenoxidase in beta vulgaris. Plant Physiology, 1949;24:1-15.
3. Gomez KA, Gomez AA. Statistical Procedures for Agricultural Research. 2ndEdn. John Wiley and Sons, New York, 2010.
4. Horneck DS, Ellsworth JW, Hopkins BG, Sullivan DM, Stevens RG. Managing Salt-Affected Soils for Crop Production. PNW 601-E. Oregon State University, University of Idaho, Washington State University, 2007.
5. Jakhar RK, Yadav BL. Effect of different RSC waters and zinc fertilization on nutrient ratios of fenugreek. Indian Journal of Agriculture Research. 2016;50:370-373.
6. Kumawat SR, Yadav BL. Effect of zinc and vermicompost on fenugreek (*Trigonellafoenum-graecum* L.) under irrigation with different RSC water. *Journal of Food Legumes*. 2011;25:156-158.
7. Lynch J, Lauchli A. Salt stress distributes the calcium nutrition of barley (*Hordeum vulgare* L.). *New Physiology*. 1985;99:345-354
8. Naga SR, Yadav BL, Sharma SR. Effect of different levels of RSC in irrigation waters, zinc and iron on soil properties and yield of wheat on loamy sand soil. *Green Farming*. 2013;4:330-333.
9. Nui X, Bresson RA, Hasgawa PM, Padro JM. lon homeostasis in NaCl stress environments. *Plant Physiology*. 1995;109:735-742.
10. Pathan ARK. Effect of zinc application on tolerant and sensitive varieties of wheat (*Triticum aestivum* L.) grown on sodic soil. *Ph. D. Thesis*, RAU, Bikaner, 2001.
11. Patra DD, Singh D, Chand S, Anwar M, Prasad A. Growth and nutrient accumulation in isabgol (*Plantago ovata*) under sodic soil. *Journal of Indian the Society of Soil Science*. 2002;50:294-298.
12. Rao JSP, Rao KB. Effect of iron stress on growth and inorganic composition of groundnut, blackgram and green gram. *Journal of Maharashtra Agriculture university*. 1994;19:249 -251.
13. Yadav KK, Chippa BR. Effect of FYM, gypsum and iron pyrites on fertility status of soil and yield of wheat irrigation with high RSC water. *Journal of the Indian Society of Soil Science*. 2007;55(23):324-329.