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Effect of organic manures and iron application on productivity of wheat and soil properties under irrigation with alkali water

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Abstract
The field experiment was carried out to investigate the "Effect of Organic Manures and Iron Application on Soil Properties, Nutrient Availability and Yield of Wheat (*Triticum aestivum* L.) Under Alkali Water irrigation" was carried out to assess the impact of different alkali water, organic manures and iron on soil properties (ECe, pHs, OC, ESP, CEC) and productivity of wheat. The experiment was set up in a split-plot design with three levels of alkali water (RSC mmol L^{-1}), (2.0, 6 and 10 mmol L^{-1}), organic manures (control (M_0), FYM@ 15 t ha^{-1}(M_1), and vermicompost @ 5 t ha^{-1} (M_2) in the main plot and four levels of iron (control, 50, 100, and 150 kg $FeSO_4.7H_2O$ ha^{-1}) in the sub-plot. The findings revealed that as alkali water irrigation levels increased, the ECe, OC, available N, P, and K, content of soil after harvest of crop, grain and stover yield decreased significantly, while pHs and ESP increased significantly. The use of FYM @15 t ha^{-1} and vermicompost @ 5 t ha^{-1} resulted in a significant decrease in soil pHs and ESP, while CEC, OC, available N, P and K content of soil, grain and stover yield increased significantly. The grain and stover yield increased significantly with increasing levels of iron.

Keywords: Alkali water, CEC, ESP, FYM, vermicompost

Introduction

The occurrence of salt-affected soils on the earth's surface dates back to the early of time (Sharma and Chaudhary, 2012) [13]. At the moment, India's salt-affected soils are estimated to be 6.73 Mha, distributed throughout a number of states. There are 2.96 million hectares of saline soils and 3.77 million hectares of sodic soils (Sharma, 2012) [13. 14]. Only 16 percent of underground water in Rajasthan is good, 16 percent is marginal, and 68 percent is of low quality, although the distribution of saline, sodic, and saline sodic waters in the poor quality water category is around 16, 35, and 49 percent, respectively (Sen, 2003) [12]. The underground water suitable for irrigation in various regions of Rajasthan, Gujarat, Punjab, Haryana, Uttar Pradesh, Andhra Pradesh, and Karnataka has a high sodicity (EC-variable, SAR>10, and RSC>4 me L^{-1}). Sodic water having more than 2.5 me L^{-1} of residual sodium carbonate (RSC) has been deemed unfit for irrigation (Wilcox *et al.*, 1954) [15]. Gupta (1983) [3] found that irrigation water with RSC as high as 10 me L^{-1} (EC 2 dSm^{-1}, SAR 10) may be sprayed continuously on sandy loam calcareous soils when rainfall is 500-550 mm during the monsoon season without affecting yield.

Wheat [*Triticum aestivum* (L.) emend]is one of the world's and India's most important staple food crops. It may be grown in a variety of soil and climatic conditions. After rice, it is India's second most significant food crop. It is a nutritious diet that contains around 78 percent carbohydrates, 12 percent protein, 2 percent fat, and minerals, as well as a significant quantity of vitamins (Kumar *et al.*, 2011). India has the largest area under wheat (34.6 million hectares), but ranks second in production (107.86 million tonnes) after China with the average productivity of 3154 kg ha^{-1} (GOI, 2019-20). Uttar Pradesh, Madhya Pradesh, Punjab, Rajasthan, Haryana, Bihar, Gujarat, and Maharashtra are the biggest producers. Uttar Pradesh is the most populous state in India in terms of both area and production, but Punjab is the most productive. The crop is grown on 3.4 million hectares in Rajasthan, with a total yield of 13.8 million tonnes and an average productivity of 3971 kg ha^{-1} (GOR, 2019-20).

Organic matter's importance has been proven by its ability to improve the physical conditions of soils for crop development in addition to its role as fertilizer. The efficacy of various organic additions such as manure and compost in the restoration of salty sodic soils has been studied (Diez & Krauss 1997). Organic additions to soil reduce bulk density while increasing CEC and water holding capacity, resulting in a diluting impact on alkali soil. Organic matter works to prevent salt from building up in soils (Gupta *et al*., 1984a) [4]. The process of vermicomposting tends to result in higher levels of plant- availability of most nutrients than does the conventional composting process. Meanwhile, even when plants are receiving adequate nourishment, vermicompost stimulates further plant development.

Iron, being a vital micronutrient, participates actively in the plant's metabolic processes. It stimulates the enzymes dehydrogenase, protease, and peptidases, all of which are involved in the direct or indirect synthesis of carbohydrates and proteins. The existence of cytochromes for conducting various photosynthetic reduction activities is reflected by the amount of iron in chloroplast. Ferredoxins are Fe-S proteins that are the photosynthetic electron transport chain's first stable redox molecule (Haviln *et al*., 1997).

Material and Methods

The experiments were conducted during *rabi* season 2019-2012 at Agronomy Farm, S.K.N. College of Agriculture, Jobner (Rajasthan). Jobner is situated 45 km west of Jaipur at $26^0 05'$ North latitude and $75^0 28'$ East longitude at an altitude of 427 meter above mean sea level (MSL). This area is classified as agro-climatic zone III-a (Semi Arid Eastern Plain). In total, 36 treatment combinations were tested, including three levels of alkali water treatment (Control, FYM @15 t ha^{-1}, and vermicompost @ 5 t ha^{-1}), three organic manures (Control, FYM @15 t ha-1, and vermicompost @ 5 t ha^{-1}), and four levels of iron ($FeSO_4.7H_2O$) (Control, 50 kg $FeSO_4.7H_2O$ ha^{-1}, 100 kg $FeSO_4.7H_2O$. In a split plot design, the treatments were reproduced three times. In this way, 36 treatment combinations were allocated randomly to different plots by using random number from the Table of Fisher (1950). The same set of treatment in the every plot was repeated during second year of experimentations.

Quality of irrigation water

Different alkali waters were used to irrigate the test crop. The required amounts of NaCl, Na_2SO_4, $NaHCO_3$, $CaCl_2$, and $MgCl_2$ were dissolved in base water to make the various alkali levels in irrigation water (control). At the crown root initiation stage (CRI), all plots were watered with normal tube well water (base water), and then the crop was irrigated 5 times with different alkali water over the whole growth phase, as per the experiment plan. Buffer strips around each irrigation channel were kept to check the lateral movement of water and salts. The composition of the prepared waters is given in table 1.

Table 1: Composition of different irrigation water

RSC (mmol L^{-1})	EC (dSm^{-1})	SAR	Ionic composition (mmol L^{-1})						
			Na^+	Ca^{2+}	Mg^{2+}	HCO_3^-	CO_3^-	Cl^-	SO_4^-
2.0 (Base water)	1.3	8.2	10	1.5	1.5	4.5	0.5	6.5	1.5
6.0	3.2	16.7	26.4	2.5	2.5	10.0	1.0	10.5	10.5
10.0	3.2	16.7	26.4	2.5	2.5	12.0	3.0	8.5	8.5

Exchangeable Sodium Percentage

ESP of soil was determined by using the formula as given by Richards, 1954.

$$ESP = \frac{Exch.Na^+[cmol(P^+)kg^{-1}]}{CEC\ [cmol(P^+)\ kg^{-1}]} \times 100$$

Results and Discussion

pHs of soil

In both years, increasing the amount of alkali water used in irrigation dramatically increased the pHs of the soil, as shown in Table 2. Level W_{10} had the highest value of soil pHs in both the years and the pooled mean, much outnumbering W_2 and W_6. Over W_2 and W_6, this treatment W_{10} raised the pooled mean pH by 9.65 and 7.70 percent, respectively. When compared to the control, the treatment of 15 t FYM ha^{-1} and 5 t ha^{-1} vermicompost resulted in a considerable drop in soil pH. Furthermore, the findings demonstrate that increasing iron levels resulted in a non-significant reduction in soil pH across both years and pooled data. he highest soil pH (8.92) was observed under control, but when FYM and vermicompost were added, it was reduced to 6.39 and 4.15 percent, respectively. According to the findings (Tables 2), increasing the amount of alkali water used in irrigation raised soil pH. The rise in pHs can be explained by increased sodicity and reduced calcium activity in irrigation water, or greater residual alkalinity and lower pCO2 in soil solution (Bear 1976). Organic matter/crop wastes form organic acids/compounds during decomposition, which reduce soil pHs, according to Jakhar *et al.* (2013) [5] and Doodhwal *et al.* (2018) [2]. Wong *et al.* (2010) [17].

Electrical conductivity (ECe)

The ECe of soil at harvest decreased significantly with increased alkali water levels of soil Table 2, W_2 had the highest pooled ECe of soil, whereas W_{10} had the lowest. W_{10} reduced the pooled mean ECe by 15.75 and 6.81 percent, respectively, as compared to W_2 and W_6, respectively. whle, the application of various organic manures and iron had no significant effect on the ECe of soil over both the years and the pooled mean. The observed decrease in ECe due to alkali water application can be attributed to the fact that the amount of calcium and magnesium in soil solution decreased due to carbonate precipitation and conversion of soluble sodium to adsorbed state, lowering the electrolyte concentration in the soil solution and lowering the ECe of soil. These findings indicate that irrigation with alkali water did not lead to an increase in soluble salts in the soil solution Chander *et al*., (1994) [1].

Cation exchange capacity (CEC)

Table 2 clearly shows that raising the alkali water level in the soil had no effect on the cation exchange capacity of the soil, however the CEC of the soil increased significantly due to the application of organic manures over the control. FYM and vermicompost treatment raised soil CEC by 10.03 and 6.35 percent, respectively, over control in a pooled mean study, but raising iron levels had no effect on soil cation exchange capacity. Increases in soil pH caused by increased alkali/RSC water in irrigation result in a non-significant rise in soil CEC. The presence of potential determining ions like as carbonates and highly charged humic materials may also be responsible for enhanced cation exchange capacity when ESP and pHs are high (Gupta *et al*., 1984) [4]. A multitude of complicated reactions occurred during the breakdown of FYM and vermicompost, resulting in the generation of acids and other stable organic ligands. The availability of most plant nutrients improved due to the lower pHs. This might be due to the enhanced cation exchange capacity and chelating effect of the soil.

Exchangeable Sodium Percentage (ESP)

The evidence described in Table 3 further indicate that W_{10} had the highest pooled ESP, which was 30.35 and 16.07 percent higher than W_2 and W_6, respectively while the application of organic manure significant decrease in ESP of soil was significantly highest under the treatment of FYM and vermicompost application, at 11.74 and 9.78 percent, respectively, over control and iron levels had non-significant impact on soil ESP during both the years and on a pooled mean basis The results (Tables 3) illustrate that increasing the level of alkali water in irrigation raised the ESP of the soil. Increase in soil ESP may be due to precipitation of Ca and Mg as carbonates, providing more opportunities for Na to be adsorbed on the exchange complex. The findings corroborate Prasad *et al.*, (2010) [10], Pareek and Yadav (2011). This is due to surplus salt is attracted to organic matter's abundantly accessible negative sites, lowering ESP and improving soil flocculation by boosting van der waals forces between clay particles. (Wong *et al*., (2008, 2010) [16, 17].

Organic carbon

When compared to W_6 and W_2, the organic carbon content of soil was reduced by 15.24 and 22.22 percent, respectively, when W_{10} water was applied (control). The decrease in organic carbon in high alkali irrigation water might be explained by low biological activity, which is not conducive to the build-up of organic matter and its mineralization (Swarup *et al*. 2000). Organic manure treatment, on the other hand, significantly increased soil organic carbon content. In the 15 t FYM and 5 t vermicompost treatments, maximum pooled organic carbon was found to be 27.80 and 22.99 percent higher than control, respectively, and iron application may have no influence on the organic carbon status of soil during crop harvest. The addition of FYM and vermicompost significantly increased the soil's organic carbon content (Table 3). The elevation in organic carbon content in the organic manure-treated plot might be due to organic matter being absorbed quickly into the soil by Singh *et al*. (2019).

Available nitrogen

Table 4 depicts that increasing the amount of alkali water in the soil after crop harvest decreased the available N content in the soil W_{10} had the lowest available nitrogen content. W_{10} lowered the pooled mean available N content by 8.10 and 2.07 percent respectively, when compared to W_2 and W_6 levels while applied organic manures were associated with significant increase in available soil N content application of 15 t FYM ha^{-1} (M_1) and 5 t ha^{-1} vermicompost (M_2) significantly increased the soil available N content by 6.58 and 4.74 percent as compared to control (M_0) in pooled mean data while applied iron also have non-significant effect on available N content of soil. The significant increase in available N content of soil as a result of FYM treatment might be attributed to N mineralization by FYM in the soil Yaduvanshi, (2001) [18].

Available phosphorus

Increased amounts of alkali water in irrigation lowered available P significantly across both years, according to data on available phosphorus content of soil at harvest (Table 4). The use of alkali water (W_{10} mmol L^{-1}) resulted in a 9.60 and 1.15 percent reduction in pooled accessible phosphorus content, over W_2 and W_6, while the treatment of different organic manures resulted in a significant increase in available phosphorus over the control, with the increase in available phosphorus content of soil with FYM and vermicompost treatment being 9.92 and 6.25 percent higher than control. The increase in soil accessible P might be attributable to enhanced native P mobilisation through vigorous root growth and biomass contribution. Organic matter may have also decreased P fixation by enhancing protective cover on sesquioxide and chelating cations such as Ca^{2+} and Mg^{2+}, resulting in increased P availability. Singh *et al*., (2008).

Available potassium

According to the results in Table 4, a declining trend in available potassium content of soil after crop harvest was seen with increasing levels of alkali water. The treatment W_2 had the highest pooled available K (149.35 kg ha^{-1}), which was 4.98 percent greater than W_{10} on a pooled mean basis. The availability of N, P, and K reduced as alkali water levels increased, which might be related to the high pHs of the soil. As the pHs of the soil rises, biological activity decreases, which is detrimental for organic matter and mineralization in the soil. High pHs and sodicity have a negative impact on transformations. The conversions and availability of nutrients in soil are further harmed by high soil pHs combined with inadequate physical conditions, while the application of 15 t FYM ha^{-1} and 5 t vermicompost ha^{-1} increased the available potassium content of the soil by 3.28 and 1.49 percent, respectively, over the control and application of iron sulphate did not affect the available potassium content of soil after harvest in both the years and in pooled mean analysis. Organic manures, in addition to having an ameliorative impact, are a storehouse of nearly all of the nutrients necessary for plant growth, as well as providing a better soil environment by improving the physio-chemical characteristics of the soil. The buildup of available soil K under FYM application was the result of additional K supplied through it, the solubilizing action of certain organic acids produced during decomposition and its greater capacity to hold K in the available form, Yaduvanshi, (2001) [18].

Grain and stover yield

The results (Table 5) suggest that higher alkali water levels decreased wheat grain and stover production. The highest pooled grain and stove yield was found under W_2, which was significantly greater by 33.85, 31.03, and 10.29, 19.56 percent due to the application of W_{10} and W_6 RSC water. Wheat grain and stover yields dropped as the amount of alkali water used in irrigation increased (Table 5). This might be explained by the fact that increasing alkali water in irrigation increased soil ESP and pH, lowering P, K, Ca, and Mg availability while increasing Na absorption, which is harmful to plants. According to Naga *et al*., (2015) [8] and Singh *et al*., (2015), increasing Na levels may have a negative impact on plant physiological, metabolic, and enzymatic activities, as well as photosynthate consumption (2018). On the other hand, the application of 15 t FYM ha-1 and 5 t vermicompost ha-1 remained consistent. Using 15 t FYM ha-1 and 5 t vermicompost ha-1, grain and stover yields improved by 30.71, 31.10, and 34.62, 33.34 percent over control in the pooled mean, respectively. A general improvement in the soil environment as a result of reduced pHs and ESP under the action of organic manures might explain the rise in production and yield characteristics. These beneficial effects encouraged increased plant nutrient availability and constant delivery throughout growth for optimal development. More carbohydrate synthesis and efficient partitioning into multiple sinks, including reproductive structures, were supported by improved nutrient availability and a suitable environment for their absorption, leading in significant gains in effective tillers and grain output. Wheat vegetative growth enhanced, leading in a larger yield of stover. Similar results were also reported by Thakur *et al.*, (2011), Choudhary *et al.*, (2020). Similarly, iron application had a major effect on wheat grain and stover production. For both years and the pooled mean, the highest grain and stover yields were achieved when 100 kg $FeSO_4$ ha-1 (F_{100}) was applied, which was substantially greater than control (F_0) and 50 $FeSO_4$ ha-1 (F_{50}), but equivalent to 150 $FeSO_4$ ha-1 (F_{150}). When compared to no treatment, F_{100} and F_{50} enhanced pooled grain output by 29.31, 35.84, and 17.88, 21.26 percent, respectively. Because of the favourable nutritional environment in the rhizosphere and higher nutrient absorption by the plant, which resulted in increased photosynthesis efficiency and production of assimilates, efficient partitioning of photosynthates in different vegetative and reproductive structures, particularly the grain, which is the ultimate sink, may have favoured efficient partitioning of photosynthates in different vegetative and reproductive structures. Increased photosynthate translocation in reproductive structures resulted in a rise in the number of effective tillers, test weight, and, ultimately, wheat grain and stover production. The results of present investigation are in conformity with those Memon *et al.,* (2013) [7].

Table 2: Effect of application of different alkali water, organic manures and iron on pHs,ECe and CEC of soil after harvest of crop

Treatments	pHs			ECe (dSm-1)			CEC [cmol (P+) kg-1]		
	2019-20	2020-21	Pooled	2019-20	2020-21	Pooled	2019-20	2020-21	Pooled
Alkali water (RSC mmol L-1)									
W_2(2 Base water)	8.28	8.30	8.29	1.51	1.42	1.46	6.40	6.06	6.23
W_6(6)	8.41	8.47	8.44	1.34	1.30	1.32	6.53	6.12	6.32
W_{10} (10)	9.03	9.15	9.09	1.26	1.20	1.23	6.55	6.18	6.36
SEm±	0.056	0.060	0.043	0.009	0.013	0.008	0.066	0.055	0.043
CD (P=0.05)	0.167	0.179	0.125	0.028	0.039	0.023	NS	NS	NS
Organic manures									
M_0 (Control)	8.89	8.96	8.92	1.38	1.32	1.35	6.16	5.79	5.98
M_1(FYM @ 15 t ha-1)	8.32	8.38	8.35	1.37	1.31	1.34	6.75	6.41	6.58
M_2(Vermicompost @ 5 t ha-1)	8.50	8.59	8.55	1.36	1.30	1.33	6.56	6.17	6.36
SEm±	0.056	0.060	0.043	0.009	0.013	0.008	0.066	0.055	0.043
CD (P=0.05)	0.167	0.179	0.125	NS	NS	NS	0.198	0.164	0.124
Iron levels ($FeSO_4$ .7H_2O)									
F_0 (Control)	8.61	8.68	8.64	1.36	1.30	1.33	6.43	6.09	6.26
F_{50} (50 kg ha-1)	8.59	8.66	8.63	1.37	1.31	1.34	6.57	6.23	6.40
F_{100}(100 kg ha-1)	8.57	8.64	8.60	1.38	1.32	1.35	6.56	6.07	6.31
F_{150} (150 kg ha-1)	8.53	8.59	8.56	1.37	1.30	1.34	6.40	6.10	6.25
SEm±	0.052	0.096	0.055	0.010	0.011	0.008	0.076	0.063	0.049
CD (P=0.05)	NS	NS	NS	NS	NS	NS	NS	NS	NS

Table 3: Effect of application of different alkali water, organic manures and iron on ESP (Exchangeable Sodium Percentage) and organic carbon in soil after harvest of crop

Treatments	ESP			Organic carbon (g kg-1)		
	2019-20	2020-21	Pooled	2019-20	2020-21	Pooled
Alkali water (RSC mmol L-1)						
W_2(2 Base water)	11.08	12.18	11.63	2.41	2.46	2.43
W_6(6)	12.44	13.67	13.06	2.21	2.25	2.23
W_{10} (10)	14.69	15.62	15.16	1.88	1.90	1.89
SEm±	0.089	0.049	0.051	0.023	0.029	0.019
CD (P=0.05)	0.266	0.147	0.148	0.069	0.088	0.054
Organic manures						
M_0 (Control)	13.81	14.81	14.31	1.84	1.89	1.87
M_1(FYM @ 15 t ha-1)	12.03	13.23	12.63	2.37	2.42	2.39
M_2(Vermicompost @ 5 t ha-1)	12.37	13.45	12.91	2.29	2.30	2.30
SEm±	0.089	0.049	0.051	0.023	0.029	0.019
CD (P=0.05)	0.266	0.147	0.148	0.069	0.088	0.054
Iron levels ($FeSO_4$ .7H_2O)						
F_0 (Control)	12.88	13.87	13.37	2.12	2.16	2.14
F_{50} (50 kg ha-1)	12.78	13.85	13.32	2.18	2.22	2.20
F_{100}(100 kg ha-1)	12.70	13.87	13.29	2.20	2.25	2.22
F_{150} (150 kg ha-1)	12.59	13.71	13.15	2.16	2.19	2.18
SEm±	0.079	0.060	0.050	0.022	0.028	0.018
CD (P=0.05)	NS	NS	NS	NS	NS	NS

Table 4: Effect of application of different alkali water, organic manures and iron on available nitrogen (N), phosphorus (P) and potassium (K) content in soil after harvest of crop

Treatments	Available N (kg ha^{-1})			Available P (kg ha^{-1})			Available K (kg ha^{-1})		
	2019-20	2020-21	Pooled	2019-20	2020-21	Pooled	2019-20	2020-21	Pooled
Alkali water (RSC mmol L^{-1})									
W_2(2 Base water)	140.19	141.16	140.67	10.35	10.46	10.41	149.22	149.49	149.35
W_6(6)	131.73	132.29	132.01	9.46	9.53	9.49	147.66	148.04	147.85
W_{10} (10)	128.93	129.62	129.27	9.38	9.43	9.41	142.06	142.46	142.26
SEm±	0.65	0.51	0.41	0.10	0.10	0.07	0.80	0.70	0.53
CD (P=0.05)	1.95	1.53	1.19	0.31	0.30	0.21	2.39	2.09	1.53
Organic manures									
M_0 (Control)	128.63	129.60	129.11	9.21	9.33	9.27	143.94	144.43	144.19
M_1(FYM @ 15 t ha^{-1})	137.33	137.89	137.61	10.16	10.23	10.19	148.80	149.05	148.92
M_2(Vermicompost @ 5 t ha^{-1})	134.89	135.58	135.23	9.82	9.87	9.85	146.19	146.50	146.35
SEm±	0.65	0.51	0.41	0.10	0.10	0.07	0.80	0.70	0.53
CD (P=0.05)	1.95	1.53	1.19	0.31	0.30	0.21	2.39	2.09	1.53
Iron levels ($FeSO_4 .7H_2O$)									
F_0 (Control)	134.01	134.64	134.32	9.62	9.67	9.65	146.29	146.52	146.40
F_{50} (50 kg ha^{-1})	133.02	133.92	133.47	9.65	9.68	9.67	146.43	146.82	146.62
F_{100}(100 kg ha^{-1})	134.00	134.66	134.33	9.83	9.95	9.89	146.46	146.87	146.67
F_{150} (150 kg ha^{-1})	133.45	134.19	133.82	9.82	9.93	9.87	146.07	146.43	146.25
SEm±	0.68	0.60	0.45	0.13	0.13	0.09	0.64	0.62	0.45
CD (P=0.05)	NS	NS	NS	NS	NS	NS	NS	NS	NS

Table: 5: Effect of application of different alkali water, organic manures and iron on grain and stover yield (q ha^{-1}) of wheat

Treatments	Grain yield (q ha^{-1})			Stover yield (q ha^{-1})		
	2019-20	2020-21	Pooled	2019-20	2020-21	Pooled
Alkali water (RSC mmol L^{-1})						
W_2(2 Base water)	35.56	34.10	34.83	56.32	54.32	55.32
W_6(6)	32.13	31.03	31.58	48.33	46.54	47.43
W_{10} (10)	26.72	25.31	26.02	38.65	37.66	38.15
SEm±	0.55	0.47	0.36	0.84	0.63	0.53
CD (P=0.05)	1.66	1.41	1.05	2.52	1.90	1.52
Organic manures						
M_0 (Control)	26.13	24.47	25.30	39.36	37.92	38.64
M_1(FYM @ 15 t ha^{-1})	33.69	32.44	33.07	51.67	49.65	50.66
M_2(Vermicompost @ 5 t ha^{-1})	34.58	33.53	34.06	52.26	50.94	51.60
SEm±	0.55	0.47	0.36	0.84	0.63	0.53
CD (P=0.05)	1.66	1.41	1.05	2.52	1.90	1.52
Iron levels ($FeSO_4 .7H_2O$)						
F_0 (Control)	27.10	25.21	26.16	39.61	37.05	38.33
F_{50} (50 kg ha^{-1})	31.22	30.46	30.84	47.11	45.85	46.48
F_{100}(100 kg ha^{-1})	34.37	33.29	33.83	52.58	51.57	52.07
F_{150} (150 kg ha^{-1})	33.17	31.63	32.40	51.76	50.23	50.99
SEm±	0.72	0.71	0.51	0.80	0.82	0.57
CD (P=0.05)	2.05	2.02	1.42	2.28	2.32	1.61

Conclusion
Changes in pHs, ECe, CEC, ESP, organic carbon, nutrient availability and yield of wheat in response to applied farm yard manure @ 15 t ha^{-1} and vermicompost @ 5 t ha^{-1} had a positive effect on soil under irrigation with varying levels of alkali water. The grain and stover yield of wheat and availability of P in soil after crop harvest significantly increased with increasing levels of iron, while, the application of iron did not affect chemical properties and nutrient availability of N and K with various alkali waters.

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