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Effect of integrated nutrient management practices on soil properties and nutrient availability to wheat (*Triticumaestivum* L.) under saline and non saline irrigation water

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Abstract
Integrated nutrient management studies in wheat (*T. aestivum* L.) cultivar WH-711 under saline and non saline irrigation water conducted during*rabi* seasons of 2011-2012 and 2012-2013at Hisar, Haryana. Available N, P, K (kg/ha) and organic carbon (%) were significantly higher under canal water treatment (173.3, 12.73, 246.3, 0.364) than saline water (171.3, 12.50, 244.5, 0.352), respectively, while soil pH did not differ significantly after completion of the experiment. Significantly higher electrical conductivity was observed under saline water (1.25 dS/m) as compared to canal water treatment (0.42 dS/m). Among inoculation treatments, available N, P, K and organic carbon were significantly higher under *Azotobacter* ST3 +*Pseudomonas* P36 + vermicompost @ 5t/ha (173.7, 12.84, 246.8, 0.369) than no inoculation (170.6, 12.34, 243.7, 0.349), respectively, while soil pH and EC did not differ significantly. Application of 125%RDF resulted insignificantly higher available N, P and organic carbon173.2, 12.81, 0.364) as compared to 100 (172.2, 12.60, 0.357) and 75%RDF (171.6, 12.44, 0.353), respectively, while available K, soil pH and EC did not differ significantly under various recommended dose of fertilizers.

Keywords: Wheat, integrated nutrient management, soil properties, nutrient availability

Introduction
Wheat (*Triticumaestivum* L.) is the second most important staple food crop at global scenarioafter rice. In Haryana, it is grown over an area of 2.52 million hectares with production of 11.63 million tonnes and highest productivity of 4624 kg per hectare in the country during 2014-15 (Anonymous, 2016).To meet the ever-increasing demand for food of the huge population of the Indian subcontinent and to exploit the high yield potential of cereals, it requires higher fertilizer doses, which are exclusively non-renewable source of energy. However, long-term fertilizer experiments have revealed that continuous application of suboptimal doses of chemical fertilizers to soil has resulted in the deterioration of soil health in terms of organic carbon and available nutrients, environmental pollution and stagnation or decrease in crop productivity. The status of any nutrient in soils indicates its nutrient supplying capability to the crops growing on it. Only a fraction of the total nutrient present in the soil exists in readily or potentially available form and, therefore a knowledge of available nutrient status of soils is very valuable in planning fertilization of agriculture, it serves as an indicator of soil fertility and thus overall fertility status of a soil has to be assessed for each nutrient separately. Thus, integrated use of organic manures with optimal levels of NPK fertilizers is of utmost importance that will not only improve the nutrient status and soil health, but has also prove help in stabilizing crop yields over a period of time (Yadav and Kumar, 2009) [20]. Hence, it was realized to integrate bio fertilizers, chemical fertilizers and vermicomposting with an aim to improve soil properties and nutrient availability to wheat under saline and non saline irrigation water.

Materials and methods
Integrated nutrient management studies in wheat crop under saline and non saline irrigation water were conducted during *rabi* seasons of 2011-2012 and 2012-2013 at Research Farm, Department of Soil Science, of CCS, Haryana Agricultural University, Hisar. Hisar is situated in the sub-tropics (29º 10´N latitude and 75º 46´E longitudes, 215.2 above msl) in Haryana,

India. The soil of the experiment field as testedwas sandy loam in texture, low in organic carbon and available nitrogen, medium in available phosphorus and high in available potassium. WH-711 was used as seedling material, vermicompost was used as the organic source and urea,DAP and $ZnSO_4$ were used as chemical fertilizers at the recommended dose (RDF) as per the package and practices of CCSHAU. Seeds of WH-711 were inoculated with *Azotobacter* ST3 &*Pseudomonas* P36 during both the years. The experiment consisted of two levels of quality of irrigation water *viz*., canal (non saline) water and saline water (8-10 dS/m); four inoculation and vermicompost treatments (no inoculation (control), vermicompost @ 5 t/ha, *Azotobacter* ST3 + *Pseudomonas* P36 and *Azotobacter* ST3 + *Pseudomonas* P36 + vermicompost @ 5 t/ha) in main plots and three levels of fertilizer (75, 100 and 125% RDF) in sub-plots. The twenty four treatment combinations were tested in split plot design replicated thrice.
Available nitrogen in soil was determined by micro-Kjeldahl method (Subbiah and Asija, 1956).Available phosphorus was extracted with $NaHCO_3$of normality 0.5 (pH 8.5) and was determined colorimetrically (Olsen *et al*., 1954).Available potassium was extracted with 1 normal ammonium acetate and was determined by flame-photometer. Organic carbon was determined by Walkely and Black's rapid titration method (Walkely and Black, 1934) and expressed as per cent. The soil pH was determined in 1:2, soil: water suspension by using Glass electrode pH meter (Jackson, 1973). The electrical conductivity (EC) of supernatant from 1:2, soil: water suspension was determined with the help of Systronics direct reading conducting meter and expressed as dS/m. The data on quality parameters namely hectolitre weight, sedimentation value, protein content and nutrient content and uptake were analyzed using OP Stat software at 5% level of significance.

Results and discussion

In general, an increase in soil parameters namely available nitrogen, phosphorous, organic carbon and electrical conductivity was observed, while soil pH and available potassium were negatively affected after completion of two years of investigation (Table 1 & 2).

Table 1: Effect of saline water and different nutrient management practices on available N, P and Kin soil

Treatments	After completion of two year experiment		
	Availablenitrogen (kg/ha)	**Available phosphorus (kg/ha)**	**Available potassium (kg/ha)**
Quality of irrigation water			
Canal water	173.3	12.73	246.3
Saline water	171.3	12.50	244.5
SEm±	0.28	0.05	0.20
CD at 5%	0.85	0.16	0.60
Inoculation and vermicompost			
Inoculation (*Azotobacter* ST3 &*Pseudomonas* P36) + vermicompost @5t/ha	173.7	12.84	246.8
Inoculation (*Azotobacter* ST3 &*Pseudomonas* P36)	171.6	12.56	244.8
Vermicompost @5t/ha	173.4	12.74	246.4
No inoculation	170.6	12.34	243.7
SEm±	0.40	0.08	0.28
CD at 5%	1.20	0.24	0.85
Fertilizers			
75% RDF	171.6	12.44	245.1
100% RDF	172.2	12.60	245.5
125% RDF	173.2	12.81	245.7
SEm±	0.23	0.07	0.22
CD at 5%	0.67	0.20	NS

*Initial status of soil: Available N=169.8 kg/ha, P=12.1 kg/ha, K=248.2 kg/ha

Table 2: Effect of saline water and different nutrient management practices on soil organic carbon, pH and electrical conductivity

Treatments	After completion of two year experiment		
	Organic carbon (%)	**pH**	**Electrical conductivity (dS/m)**
Quality of irrigation water			
Canal water	0.364	8.21	0.42
Saline water	0.352	8.15	1.25
SEm±	0.001	0.04	0.005
CD at 5%	0.004	NS	0.014
Inoculation and vermicompost			
Inoculation (*Azotobacter* ST3 &*Pseudomonas* P36) + vermicompost @5t/ha	0.369	8.18	0.84
Inoculation (*Azotobacter* ST3 &*Pseudomonas* P36)	0.349	8.19	0.83
Vermicompost @5t/ha	0.365	8.17	0.84
No inoculation	0.349	8.19	0.83
SEm±	0.002	0.06	0.007
CD at 5%	0.006	NS	NS
Fertilizers			
75% RDF	0.353	8.19	0.83
100% RDF	0.357	8.18	0.84
125% RDF	0.364	8.18	0.84
SEm±	0.002	0.04	0.003
CD at 5%	0.006	NS	NS

*Initial status of soil: Organic carbon= 0.34, pH=8.26 and EC=0.40 dS/m

Available nitrogen, phosphorous and potassium (kg/ha)

In present studies, canal water application resulted in significantly higher available N (173.3 kg/ha) and P (12.73 kg/ha) as compared to saline water (171.3 kg/ha, 12.50 kg/ha), respectively after completion of two years of investigation (Table 1). Likewise, Minhas and Gupta (1992) [2], Pathak and Rao (1998) [13] and Prapagar *et al*. (2015) [15] reported decline in available N andP with an increase in salinity levels. Salinity is well known to depress soil microbial activity (Polonenko *et al*., 1981) [14] and inhibit nitrification (McCormick and Wolf, 1980) [18]. Prapagar *et al.* (2015) [15] stated that with increasing salt concentration N mineralization decreases which simultaneously leads to lesser N availability in soil.A regular decrease in the availability of P in presence of excessive salts appears to be due to reduced activity of phosphate ions in highly saline substrate and reduced fixation of available P at higher salinities.

Among the inoculation and vermicompost treatments, *Azotobacter* ST3 &*Pseudomonas* P36 + vermicompost @ 5t/ha treatment resulted in maximum available N and P while minimum available N and P were recorded under no inoculation. The findings are in agreement with Gaind and Lata (2007) [3], Pandey *et al*. (2009) [12], Devi *et al*. (2011) [2], Sharma *et al*. (2013) and Shukla *et al*. (2013). Increase in available N and P with vermicompost and biofertilizers application might be attributed to direct addition of N and P through vermicompost to available pool of the soil plus improved microbial activity; and direct contribution of *Azotobacter* and *Pseudomonas* in fixing atmospheric nitrogen and solublization of native phosphorous, respectively. Application of 125%RDF resulted in significantly higher available N and P (173.2, 12.81 kg/ha) than 75%RDF (171.6, 12.44 kg/ha), respectively after completion of two years of investigation. In conformity, Sharma *et al*. (2013) and Yaduvanshi and Sharma (2016) [22] reported significant increase in available N and P with increasing fertilizer levels.

In general, available K decreased after two years of investigation as compared to initial available content (248.2 kg/ha). The decrease is obvious due to higher removal of K owing to the higher yields because of K was not added to the soil, but the decrease was less pronounced in the treatments receiving vermicom post, as it contains K. Application of canal water resulted in significantly higher available K (246.2 kg/ha) than saline water (244.5 kg/ha) after completion of two years of investigation. Saqib *et al.* (2000) [17] also reported that increased concentration of Na^+ and Cl^- decreased the concentration of K^+. Application of *Azotobacter* ST3 &*Pseudomonas* P36 + vermicompost @ 5t/ha resulted in maximum available K than all other inoculation and vermicompost treatments, while minimum available K was obtained under no inoculation. The present findings are in line with Pandey *et al*. (2009) [12] and Devi *et al*. (2011) [2]. Increase in available K with vermicompost and biofertilizers application might be attributed to direct addition of K through vermicompost to available pool of the soil. There was no significant effect of different levels of fertilizer on available K after two years of investigation. Similar findings were reported by Yaduvanshi and Sharma (2016) [22].

Organic carbon (%), soil pH and electrical conductivity (dS/m): Under quality of irrigation water, canal water application resulted in significantly higherorganic carbon (0.364%) ascompared to saline water (0.352%), respectively after completion oftwo years of investigation.Likewise, Minhas and Gupta (1992) [2], Pathak and Rao (1998) [13] and Prapagar *et al*. (2015) [15] reported decline in organic carbon with an increase in salinity levels. The decline in organic carbon under saline water treatment is ascribed to the fact that saline irrigation did not contribute much towards the buildup of soil and continuous degradation of soil organic matter by microorganisms may also contribute for lesser organic carbon content. Among the inoculation and vermicompost treatments, *Azotobacter* ST3 &*Pseudomonas*P36 + vermicompost @ 5t/ha resulted in maximum organiccarbon (0.369%) while minimum and organic carbon (0.349%) wasrecorded under no inoculation after completion of two years of investigation. The findings are in agreement with Gaind and Lata (2007) [3], Pandey *et al*. (2009) [12], Devi *et al*. (2011) [2], Sharma *et al*. (2013) and Shukla *et al*. (2013). Application of125%RDF resulted in significantly higher organic carbon (0.364%) than under 100%RDF (0.357%) and 75%RDF (0.353%) after completion of two years of investigation. Sharma *et al*. (2013) and Yaduvanshi and Sharma (2016) reported significant increase in organic carbon with increasing fertilizer levels.

In present studies, none of the treatments had significant effect on soil pH, although soil pH slightly decreased as compared to initial values in all the treatments. Moreover, soil pH decreased in saline water treatment (8.15) as compared to canal water (8.21). In conformity, Hamam and Negim (2014) showed that soil pH decreased in all soil treatments irrigated with saline water from 7.95 to 7.8 with increasing water salinity. Decrease in soil pH in all the treatments could be due to displacement of protons by Na of saline irrigation water (Ghallab and Usman, 2007) [4]. Babu *et al*. (2007) [1] while working with vermicompost and FYM found that, that the release of organic acids during decomposition of these organic manures might have declined the soil pH. Non significant effect of fertilizer levels on soil pH and electrical conductivity was also reported by Sharma *et al*. (2013) and Kumara *et al*. (2014) [7].

Significantly higher electrical conductivity was observed under saline water (1.25 dS/m) as compared to canal water treatment (0.42 dS/m). The results are in agreement with Hamam and Negim (2014) who reported that saline levels of irrigation water increased soil EC in all the treatments from 3.28 to 6.22 dS/m and (Ragab *et al*., 2008) [16] who reported that values of EC for irrigated soil increased with increasing salinity water use. Different fertilizer levels and inoculation + vermicompost treatments had no significant effect on soil electrical conductivity after two years of investigation. The soil EC in present studies increased with the application of vermicompost and increasing levels of fertilizer which is in conformity with the findings of Nehra (2000) [10].

Conclusion

Based on two years of investigation, an increase in soil parameters namely available nitrogen, phosphorous, organic carbon and electrical conductivity was observed, while soil pH and available potassium were negatively affected after completion of two years of investigation.

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