Deficit saline irrigation and mulch affect soil microbial activities under zero-tilled saline soil

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INTRODUCTION

Soil biological process is the major determinant for sustainable crop production in salt-affected soils of arid and semi-arid regions. The restoration of soil microbial activities is inevitable for productive utilization of these soils. The zero tillage, mulch and deficit saline irrigation effect the primary productivity of these soils by moderating the soil biological activities under rainfed sorghum–irrigated wheat cropping system.

METHODOLOGY

The field experiment was conducted in split-plot design with three replications consisting of irrigation with 100 and 60 per cent of water requirement of wheat and mulch @ 5 Mg ha^{-1} rice straw combination in subplots since 2014. Soil samples of surface layers (0-5 and 5-15 cm) were collected after sorghum harvest (October) in 2020 and analysed of soil biological properties using standard protocol (Fig 1, 2).

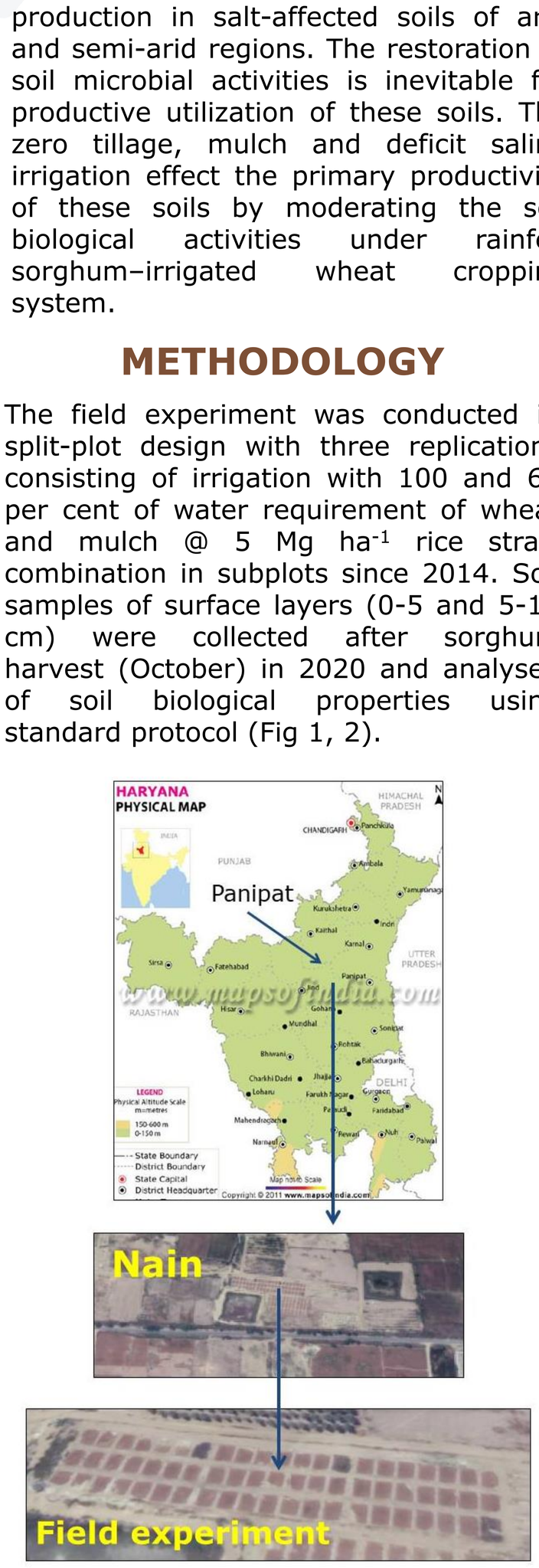


Fig 1. Location map of field experiment at CSSRI farm, Nain Panipat, Haryana, India

Fig 2. a. Initial Experimental field; (b) *kharif* (monsoon) sorghum (c) *rabi* (winter) wheat.

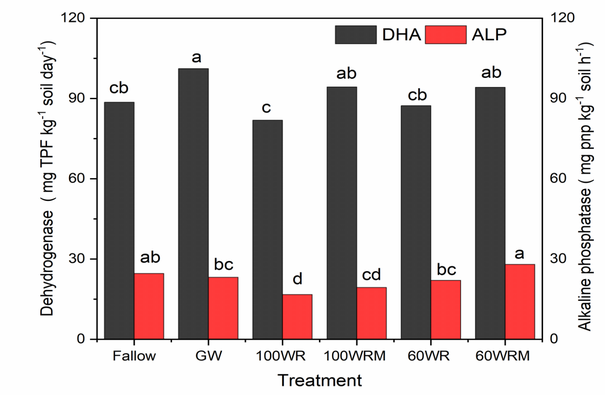
RESULTS

Application of good quality water significant decreased EC_e (2.47 dS m^{-1}); whereas, irrigation with saline water maintained similar values of EC_e (4.2 to 5.6 dS m^{-1}). Soil organic carbon (SOC) content of the fallow was greater compared to other treatments (Table 1). The SOC was similar in GW (good quality water), 100WRSW (100 per cent water requirement through saline water) and 60WRSW. Microbial biomass carbon (MBC) and N (MBN) was in the order of fallow> GW> 60WRMSW >100WRMSW. The 60WRMSW and 100WRMSW were having higher MBC: MBN ratio (MBCN) compared to fallow, GW and saline irrigation without mulch. Dehydrogenase (DHA) activity was greater in GW in both soil layers. Its activity was at par in saline water irrigated plots and fallow (Fig 3).

Table 1. Change soil EC_e (dS m^{-1}), soil organic C (g kg^{-1}) and microbial biomass C and N (mg kg^{-1}), MBCN after management practices; values followed by the same letter are not significantly different at $p < 0.05$ by Duncan's multiple-range test.

Treatments	EC_e	SOC	MBC	MBN	MBCN
Fallow	4.2^{a}	6.3^{a}	206.3^{a}	38.2^{a}	5.48^{bc}
GW	2.5^{b}	4.7^{dc}	162.1^{b}	30.2^{b}	5.46^{bc}
100WR	5.6^{a}	4.3^{d}	107.4^{c}	23.2^{bc}	4.72^{c}
100WRM	5.4^{a}	5.1^{cb}	135.3^{c}	18.8^{c}	7.33^{a}
60WR	4.9^{a}	4.8^{dcb}	118.4^{c}	18.8^{c}	6.39^{ab}
60WRM	4.7^{a}	5.3^{b}	130.3^{c}	18.0^{c}	7.36^{a}

The β-glucosidase activity (β-glu) was higher in GW; however, fluorescein diacetate hydrolysing activity (FDA) was lowest in GW and fallow in both the soil depth. Mulching favored for higher values of SOC and soil enzymes β-glu and FDA than no-mulch ($P < 0.05$). The SOC content maintained after converting the barren saline soil to cultivation was mainly because of SOC protected in soil aggregates under no tilled. Increased adsorption of SOC on numerous Lewis acid sites was also favored because of presence of HCO_3^- and SO_4^{2-} ions. Increase in salinity causes matric and osmotic stress and reduced microbial activity in fallow. Suppressive effect of mulch on these stresses further improved these soil microbial activities.



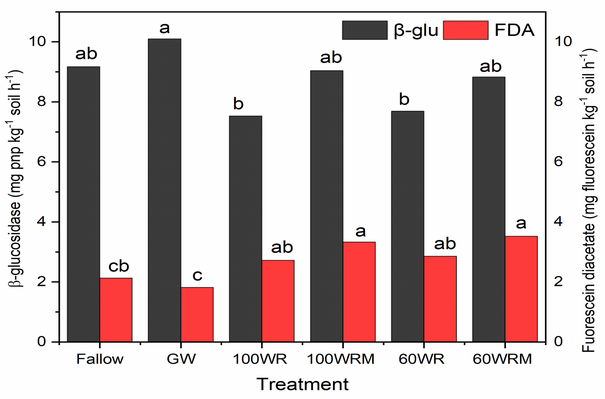


Fig 3. Change in soil enzymes activities after management practices; values followed by the same letter are not significantly different at $p < 0.05$ by Duncan's multiple-range test.

CONCLUSIONS

Benefit of improvement in soil biological properties with a reduced cost of cultivation practices viz. deficit saline irrigation and mulching is advocated for productive utilization of saline groundwater and greening barren saline land.

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