Subsurface drainage technology for reclamation of waterlogged saline soils. A case study of alluvial region

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INTRODUCTION

The waterlogged saline soils occur in about 2 million hectare area in arid and semi-arid alluvial north western states of India and more than 1 million hectares each in coastal and black cotton heavy soil (vertisol) regions of the country (Karma et al.2019). Waterlogging and salinity are serious environmental threat adversely affecting the crop yield and soil productivity. ICAR-CSSRI estimated the annual crop production and monetary losses due to the soil salinity problem at the national level as 5.66 million tonnes and US$ 1061 mn. Saline soils (ECe> 4 dS m-1, pHs< 8.2 and ESP <15 in the root zone) in irrigation commands are accompanied by shallow water table (< 2 m below the soil surface) termed as waterlogged saline or saline-sodic soils. The saline groundwater within the crop root zone restricts plant growth drastically. The improvement in physico-chemical condition is inevitable for sustainable crop production in waterlogged saline environment. Subsurface drainage (SSD), an effective technology practiced extensively worldwide, can be an effective option for amelioration of waterlogged saline areas.

METHODOLOGY

The study area was located between longitudes of 76.675 E to 76.690 E and latitudes of 29.007 N to 29.0209 N, in Rohtak district of Haryana, India (Fig. 1). For this purpose, subsurface drainage network was installed in 2016 in 160ha land which was divided in 4 operational blocks . The detail design feature of installed SSD project is given in table 1. Drainage effluent was pumped out from the sump situated at surface drain (Fig 2). Fluctuation in water table depth, spatiao-temporal changes in salinity of soil and improvement in crop yield were monitored to access the effect of SSD on amelioration of waterlogged saline soil for crop production and livelihood security of the farmers.

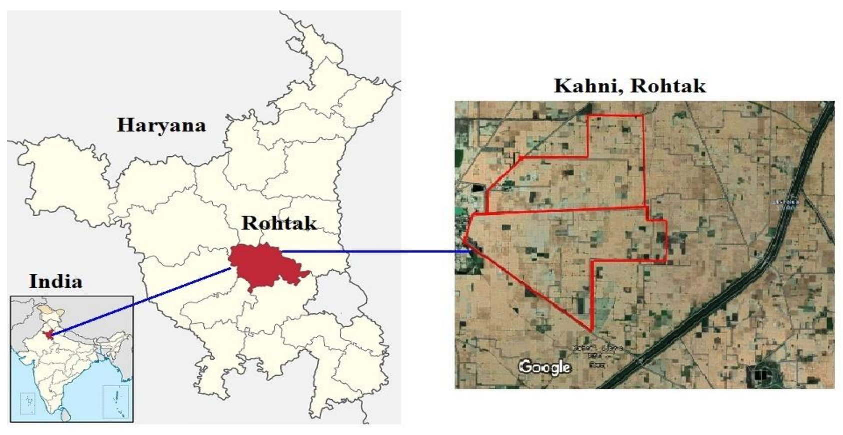

Fig 1. Sub -surfac drainage project s site, Rohtak, India

Fig 2. View of affected site in winter, installation of SSD network and pumping of drainage effluent

Table 1. Salient features of subsurface drainage system installed in project area

Parameters	Description
Type of drainage system	Pipe drainage with pump outlet
Drainage coefficient	1.5 mm/day
Drain spacing (lateral)	60 m
Drain depth(lateral)	1.2- 1.85 m
Size (lateral)	80 mm
Size of collector drain	160 mm, 200 mm

RESULTS

Post installation monitoring and evaluation at large field scale reveals a significant change in soil salinity which was translated into good crop yield. The mean electrical conductivity (ECe) of sub soil (0-135cm) profile reduced significantly within 3 years period of successful operation SSD (Fig. 3). However, the major change was noticed in upper soil profile (0-75 cm). Similarly, water table in the study field varied between 0.23 -1.45 m below ground level (bgl) during the different months of the year. The minimum water table depth was recorded in September, which was within the root zone (22.5 cm bgl. The irrigation water quality was relatively good (1.0 dS/m) which facilitated leaching of salt during initial growing season of rice and helped establishment of seedlings better. This was the reason that rice performed well even when water table was at 0.23 m bgl. In post monsoon season (after September), groundwater level started receding and reached to 1.45m in June. However, it varied between 0.42 -1.45 m below ground level (bgl) during the period of October to June (Fig. 4). The water level was below 0.5 m in November and was continuously going down onward. Since, wheat sowing in this part of country is done in the last fortnight of November, hence, SSD maintained conducive environment for wheat season (November - May).

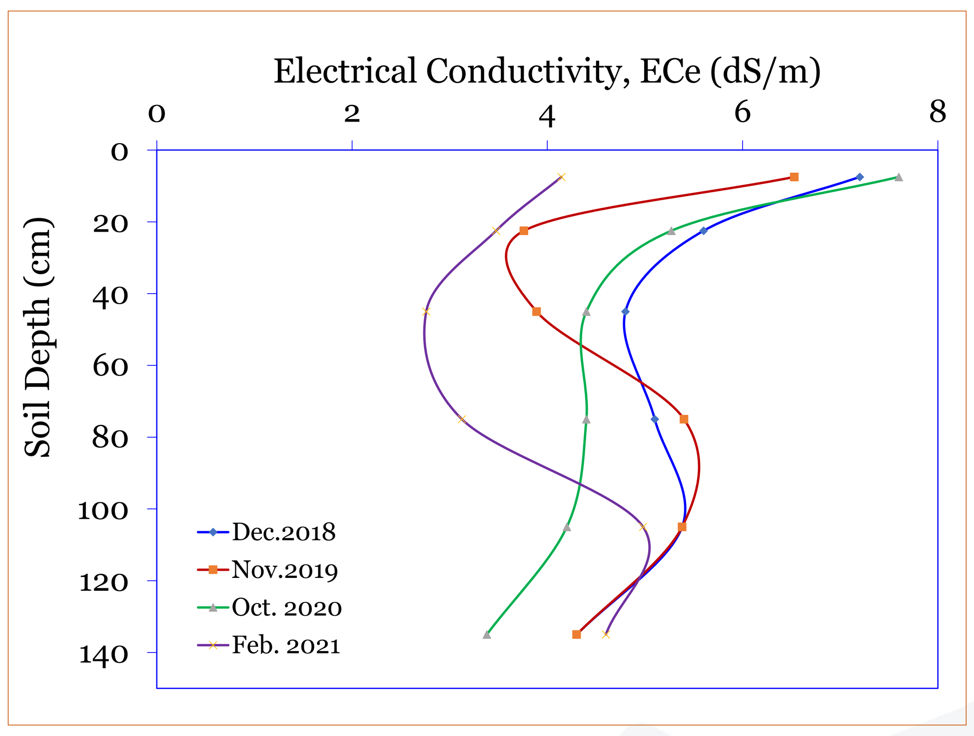

Fig 3. Temporal change in soil salinity in experimental field

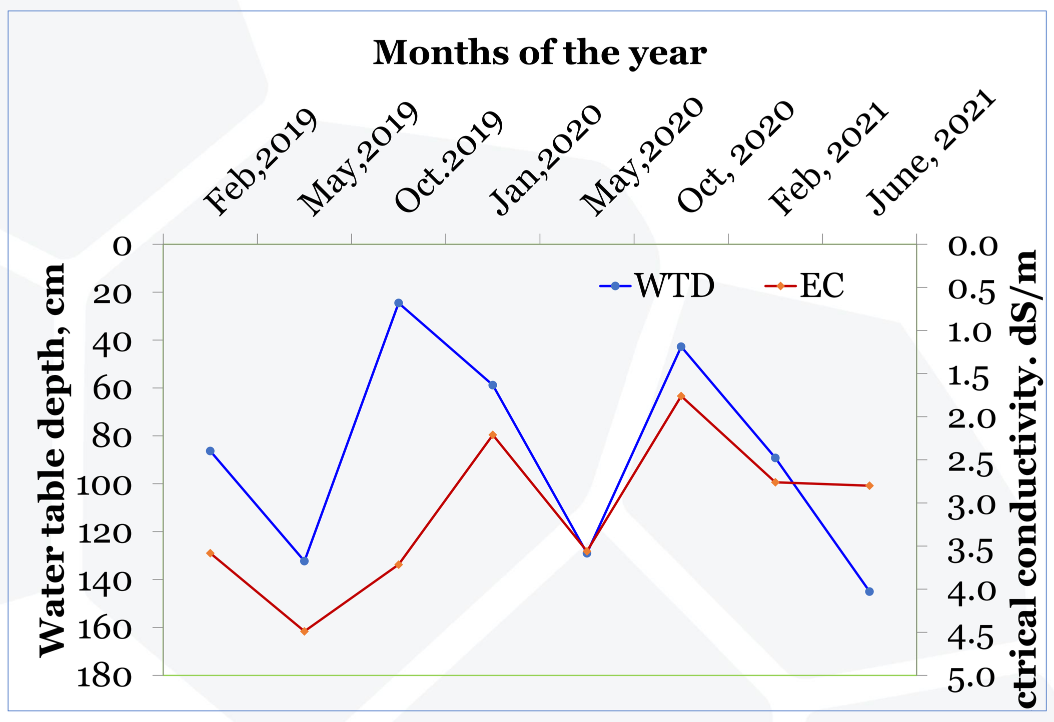

Fig 4. Temporal changes in water table depth and salinity

The conducive environment created by SSD network which translated into better plant growth and increase in crop yield (Fig. 4). The wheat yield was recorded to be 40.25 q/ha after successful operation of SSD in comparison to merely 10.4 q/ha yield recorded during commencement of SSD operation. The yield of rice was recorded as 41.6 q/ha as compared to 18.5 q/ha.

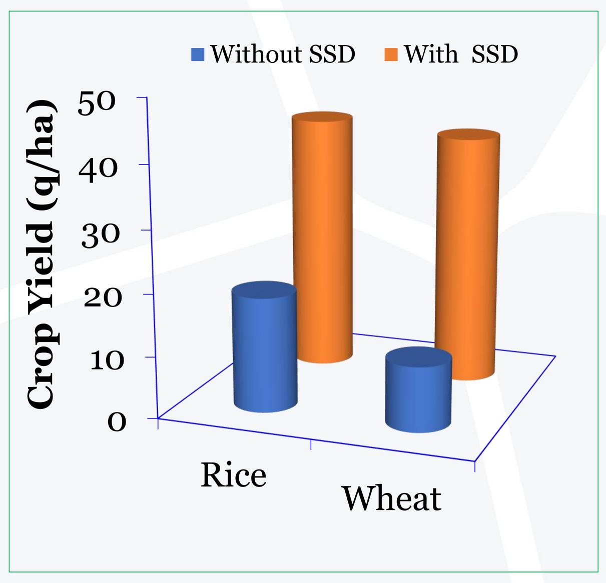

Fig 4. Rice and Wheat yield at project site

CONCLUSIONS

Maintaining lower salt load within and water table beyond root zone is essential for sustainable crop production in waterlogged saline soil. The overall results of the study revealed that SSD improved pysico-chemical condition in plant root zone and crop yield reached to 40.25 and 41.6 q/ ha for wheat and rice respectively after successful operation of SSD in waterlogged saline soil. That suggests that SSD is an effective technology for achieving sustainable crop production in waterlogged saline soils.

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