Effect of conservation agriculture and precision water management on wheat productivity and irrigation water use under rice-wheat cropping systems in the Indo- Gangetic Plains of India

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Introduction

In the present scenario the biggest challenge is to produce more food for the continually increasing world population with in the limited land and water resources. Serious water deficits, diminishing profitability and deteriorating natural resources are some of the major threats to the agricultural sustainability in many regions of South Asia. Food security and water sustainability may be achieved by bringing improvement in the crop water productivity and the amount produced per unit of water consumed. If sustainable measures are not taken soon to ensure sustainable use of groundwater, the IGP of NW India may soon experience decline in crop productivity and farm profitability, and shortages of potable water leading to extensive socio-economic stresses. The adoption of surface drip irrigation has always remained cumbersome process of anchoring laterals at the beginning and removing after every crop due to field operations. To eliminate this hurdle and looking to the constraints of water shortages in future, it is imperative that we focus on developing alternative and remunerative approaches for increasing water productivity in the 'Green Corridors' of NW India.

Photo 1 CA + sub-surface drip irrigation system

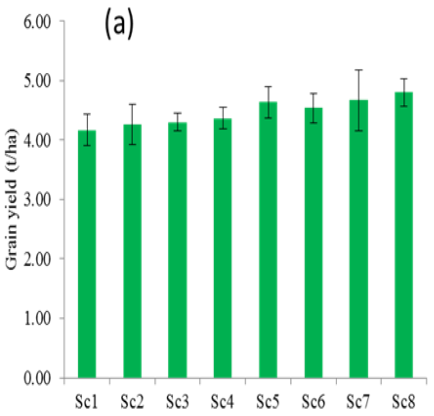

Fig.1 Grain yield under different scenarios

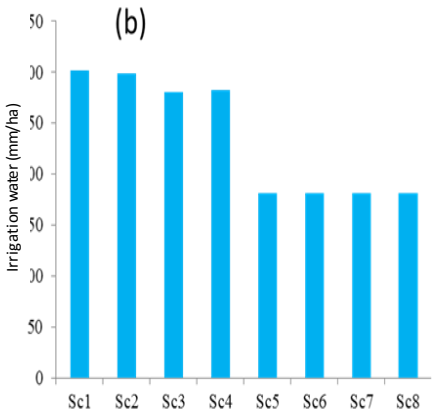

Fig. 2 Irrigation water used under different scenarios

Therefore site-specific water management (SSWM) based RZI/ SDI was evaluated first time in the country under cereal (rice/maize based) systems approach for irrigation water saving, higher water use efficiency and water productivity.

Objectives

To ensure sustainable use of groundwater, the IGP of NW India may soon experience decline in crop productivity and farm profitability, and shortages of potable water leading to extensive socio-economic stresses.

To eliminate this hurdle and looking to the constraints of water shortages in future, it is imperative that we focus on developing alternative and remunerative approaches for increasing water productivity in the 'Green Corridors' of NW India.

Methodology

The experiment was laid out in the completely randomized block design with three replications. The base soil samples were taken for site characterization before laser levelling and after that the SSDI system was layed out as per the treatment protocols. Eight scenarios were compared varied in the tillage, crop establishment, residue and irrigarion management i.e., {First four scenarios irrigated with flood irrigation method; Sc1-Conventional tillage (CT) without residue, Sc2-CT with residue, Sc3- Zero tillage (ZT) without residue, Sc4-ZT with residue}, and {last four scenarios irrigated with sub-surface drip irrigation method; Sc5-ZT without residue, Sc6- ZT with residue, Sc7-ZT inclusion legume without residue and Sc8- ZT inclusion legume with residue}.The soil of the experiment was sodic in nature with a pH (1:2, soil:water) of >8.5 at 0-15 cm soil depth.

Results

Results revealed that CA-flood irrigation (S3, Sc4) and CA-PWM system (Sc5, Sc6, Sc7 and Sc8) recorded about 3-5% and 12-15% higher wheat yield, respectively compared to Sc1 (Fig. 2a). Higher grain yield in PWM scenarios were due to favourable conditions provided for water and N supply under drip irrigation cum fertigation (Sidhu et al., 2019 and Jat et al., 2019). Sub-surface drip irrigation provide water and nutrients directly to the root zone that leads to efficient water use, prevents weed emergence, reduces labor cost, and allows direct seeding with no-tillage practices (Kakraliya et al., 2018). Similar, CA-PWM saved 30-40% irrigation water compared to Sc1 (Fig. 2b). Therefore, results of our study on best agronomic practices including CA and precision water management (subsurface drip irrigation) systems for RW rotation would be of huge interest to farmers, for addressing the existing and future challenges in the RW system.

Conclusion

The subsurface drip irrigation combined with conservation agriculture (CA) approaches like zero till, retaining residues on soil surface and dry seeding requires ~40% less irrigation water than flood irrigation for wheat with the same or higher amount of yields, and would still be cost-effective for farmers.