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Integrated weed management in conservation agriculture based rice-wheat-greengram cropping system


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Prologue/Introduction

Rice-wheat cropping system is predominant, and provides livelihood to millions of people. But, traditional rice-wheat cropping system has several problem associate with it such as deterioration in soil health, release of GHGs and soil erosion. To address these problems, adaption of conservation agriculture (CA) would be an option as it has several advantages, still establishment of perennial weeds and weed shifts are major issues. By adopting CA with IWM, crop residues burning can be avoided, soil health can be improved by enhancing physical, chemical and biological properties, and more carbon can be sequestrated in the soil profile. This approach also enhances soil moisture retention and helps in restricting the establishment of tough-to-kill weeds and weed shifts, which are challenges in the conservation tillage system with recommended herbicides.

Methodology

A split plot design was employed to evaluate five tillage in main plot [CT (DSR)+S-CT (wheat)-ZT (greengram), CT (DSR)+S+R-CT+R (wheat)-ZT+R (greengram), ZT (DSR)+S-ZT (wheat)-ZT (greengram), ZT (DSR)+S+R-ZT+R (wheat)-ZT+R (greengram) and transplanted rice-CT (wheat)-ZT (greengram)] and in sub-plot three weed management practices (weedy check, recommended herbicides and integrated weed management/herbicide rotation) during 2017 to 2021. The rice variety MTU 1010, wheat GW 273 and greengram samrat/virat were test crops and varieties. Recommended fertilizers rice (100:60:40 kg N, P_2O_5 and K_2O/ha) wheat (120:60:40 kg N, P_2O_5 and K_2O/ha) and greengram (20:60:0 kg N, P_2O_5 and K_2O/ha) were applied as per recommendation at the region. The seeds were sown with normal seed drill in CT plots and happy seeder in ZT plots. Other crop management practices were follower as recommended for the crops in the region.

Results

The adoption of CA [DSR-zero-tillage (ZT) with previous crop residues (R), ZTR] coupled with integrated weed management and herbicide rotation (IWM, bispyribac-sodium/cyhalofop+penoxsulam/fenoxaprop+ethoxysulfuon *fb* hand weeding in rice, clodinafop+metsulfuron 60+4 g/ha/mesosulfuron+iodosulfuron 12.2.4 g/ha in wheat and pendimethalin 678 g/ha *fb* hand weeding in greengram) provided lower weed density and weed biomass, higher weed control, profuse crop growth and development, more grain/seed yields, with better economical parameters in all tested crops over conventional agriculture [conventional tillage, CT with recommended herbicide (RH) bispyribac-sodium 25 g/ha in rice, mesosulfuron+iodosulfuron 12+2.4 g/ha in wheat and pendimethalin 678 g/ha in greengram]. ZTR with IWM/HR also provided broad-spectrum weed control with the highest system crop, water, energy productivity and profitability. Along with these improved the soil health, sequestrated and stabilized more carbon in the soil profile. This also helped in conserving soil from erosions and greenhouse gas emissions. Therefore, CA based agriculture with IWM can be adopted in rice-wheat-greengram cropping system.

Benefits

a. Productivity gain: The adoption of ZT(DSR)+S+R-ZT+R-ZT+R resulted in a 10% higher system productivity (SP) in terms of rice equivalent yield (11.65 t/ha) compared to the CT-CT-ZT system (10.59 t/ha), however, TPR-CT-ZT system obtained 13% more SP (11.97 t/ha) but non-sustainable. The IWM/herbicide rotation exhibited a 36.9% higher SP (14.30 t/ha) compared to the use of recommended herbicides in the system (13.40 t/ha).
b. Saving of water, labour and time: The adoption of ZT(DSR)+S+R-ZT+R-ZT+R allowed for saving of 15-21% irrigations over CT-CT-ZT system and 38-43% over transplanted rice based system. The ZT(DSR)+S+R-ZT+R-ZT+R and IWM/HR obtained 6.9% and 36.8% more irrigation water and 14.7 and 7.5% higher total water productivity, respectively. Additionally, the elimination of soil turning in CA fields saved 7-10 days over CT and 8-12 days over TPR per season, which could potentially be utilized for growing a third crop in the system.
c. Saving of energy: IWM/HR exhibited higher net energy of 200 MJ/ha, energy productivity of 0.64 kg/MJ, and nominal 2.6% higher energy profitability over recommended herbicide.
d. Conservation of soil: Protect the soil by >95% and
e. Non-point pollution: Minimal as water does not go out from these plots.
f. Early sowing practice under ZTR provided protection to wheat crop from terminal heat stress and greengram from rains. Resulting in good crop harvest with quality produce.
g. Efficiency: In the triple ZTR system (ZT(DSR)+S+R-ZT+R-ZT+R), WCE improved by 14.4-41.4% over CT system, while IWM demonstrated up to 27.3-69.2% higher WCE over the use of RH in the system.
h. Cost effectiveness including benefit cost ratio: The adoption of CA practices resulted in additional net returns of Rs 31,000/ha over CT system, with B: C of 2.67. Likewise, IWM achieved additional net returns of Rs 11000/ha over RH, with a B: C of 2.88.

Higher soil temperature in CT plots

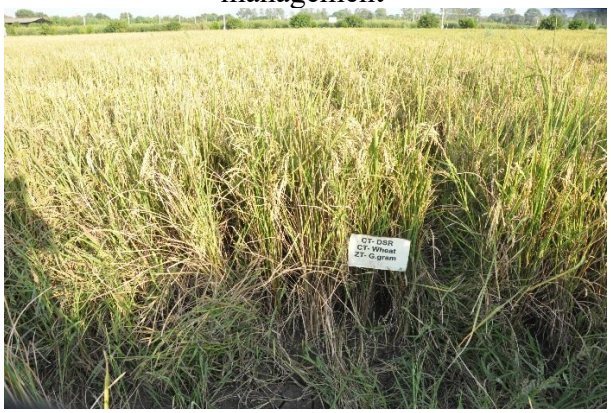
Reduced soil infiltration rate in CT plots

Showing deficit of moisture (stress) in CT plots from SMI

Rice-wheat-greengram

CT without crop residues and Integrated weed management

ZT with crop residues and Integrated weed management



CT without crop residues and bispyribac-sodium 25 g/ha

ZT with crop residues and bispyribac-sodium 25 g/ha

CT wheat with herbicides

ZT+R wheat with sulfosulfuron 25 g/ha+ clodinafop 50 g/ha

ZT+R wheat with weedy check

CT wheat with weedy check

ZT+R greengram with weedy check

ZT+R greengram with pendimethalin 678 g/ha fb HW

CT-CT-ZT greengram with weedy check

CT-CT-ZT greengram with pendimethalin 678 g/ha fb HW CT W3

Upscaling

This technology can be upscale by following ways

- Training and demonstration,
- Establishing more custom hiring centres for CA based machineries,
- Converge with state government schemes.

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