Extended Summaries Vol 3: 3rd International Agronomy Congress, Nov. 26-30, 2012, New Delhi, India

Effect of conservation agriculture on productivity and economics of different cropping systems under rainfed condition in the semi-arid tropics

RAM A. JAT*, SUHAS P. WANI, PIARA SINGH, P. PATHAK, K. SRINIVAS, UTTAM KUMAR, E. PAVANI AND R. VELMURGAN

International Crops Research Institute for the Semi-Arid Tropics, Patancheru 502 324 India
**Corresponding author's E-mail: rajatagron@gmail.com*

Continuous cropping and removal of crop residues from on lands without adequate investment for soil quality has led to land degradation like soil erosion, loss of organic matter etc. to critical limits in the semi-arid regions where soils are naturally deficit in organic matter. It is hypothesized that conservation agriculture (CA), which consists of zero/minimum tillage, crop residue retention/growing cover crops and adoption of suitable cropping systems, leads to reversal of process of land degradation when practiced continuously through significant reduction in runoff and soil loss (Castro *et al.*, 1991) as well as improvement in soil physical, chemical and biological properties (Lal, 2010). The major constraints to the use of CA in these regions include insufficient amounts of residues and degraded nature of soil resource, resource poor smallholder farmers, lack of in-depth research in the rainfed regions besides many other problems. There is need for strategic long-term research in the rainfed regions for exploring the prospects in the face of major constraints faced to the adoption of CA,

METHODOLOGY

The soil of the experimental field is a vertic Inceptisol which according to USDA soil classification, classified as a member of the fine, montmorillonite, isohyperthermic family of paralithicVerticUstopepts (Verticcambisol as per FAO classification), slightly alkaline (pH 7.91) with EC 0.22, low in organic C (0.42 %) and medium in available P (10.61 kg/ha).

Two levels of tillage (normal tillage and minimum tillage), residue management (residue retention and residue removal) and cropping systems (maize–chickpea cropping sequence and maize-pigeonpea intercropping) were tested in split-split plot design with four replications.

Tillage options were applied in main plots, while residue management treatments were applied to sub-plots. The sub- plots were further divided into sub-sub-plots into which two cropping systems *viz.* maize-chickpea and maize/pigeonpea were applied. Crops were grown on permanent beds of 1 m width interspaced with 0.5 m wide furrows.

RESULTS

Chickpea yield was also recorded significantly higher under normal tillage in 2010-11 season. During 2011-12 season, chickpea crop could not be planted due to scanty rainfall. Pigeonpea gave significantly higher yield with minimum tillage in 2010-11 season however, no yield differences were observed due to tillage practices in 2011-12 season. Yield of maize, chickpea and pigeonpea crops was not significantly affected due to residue removal or addition in both the years of the study.

Maize yield was found significantly higher in maize-chickpea system in 2010, but maize/pigeonpea system recorded significantly higher maize yield in 2011. Sole cropping of maize was mainly responsible for higher yield of maize in maize-chickpea system in 2010, but gradual improvement in soil fertility, over the years, under maize/pigeonpea system due to beneficial effects of pigeonpea like addition of large amount of readily decomposable biomass through pigeonpea leaf fall (data not given), higher amount of biologically fixed nitrogen, higher rain water infiltration through channels created by decomposition of deep and massive root system of pigeonpea, might led to higher maize yield compared to maize-chickpea system in 2011.

Normal tillage gave 9.07% higher MEY ($p<0.05$) over minimum tillage in 2011-12. Higher crop yields, mainly of maize, under normal tillage were reflected in higher MEY in 2011-12. Crop residue application or removal did not affect MEY significantly in both the years of study. Maize-chickpea sequential cropping recorded significantly higher MEY over maize/pigeonpea intercropping system during 2010-11. However, during 2011-12 maize/pigeonpea system gave significantly higher MEY over maize-chickpea sequential cropping which is attributed to higher maize yield under maize/pigeonpea intercropping system and failure of chickpea crop during 2011-12.

Even though minimum tillage gave higher net returns over normal tillage in both the years of study, the differences were not significantly different (Table 1). Similarly, tillage practices did not significantly affect B:C ratio during 2010-11, but the differences in B:C ratio were significant ($p<0.05$) in 2011-12. Removal of crop residues recorded significantly higher net returns as well B:C ratio over soil applicationof crop residues in both the years of study. This is mainly due to the cost of residues and that involved in their application. Maize-chickpea system gave significantly higher net returns and BC ratio over maize/pigeonpea intercropping system during 2010-11; however, maize/pigeonpea intercropping system recorded about 85% higher net returns ($p<0.05$) and significantly higher BC ratio over maize-chickpea system during 2011-12.

As results were not consistent during the first two years of the study, long-term study is required to determine the effects of CA on crop yield and economic returns.

Table 1. Effects of tillage, residues and cropping systems on yield of maize, chickpea and pigeonpea, MEY, net returns and BC ratio in SAT region of India.

	Maize (t/ha)		Chickpea (t/ha)		Pigeonpea (t/ha)		Maize equivalent yield (t/ha)		Net returns (000 (₹/ha)		B:C ratio	
	2010	2011	2010-11	2011-12	2010-11	2011-12	2010-11	2011-12	2010-11	2011-12	2010-11	2011-12
Tillage practices												
Normal tillage	5.8	5.6	1.1	-	0.4	0.5	8.0	6.5	42.3	27.3	2.21	1.75
Minimum tillage	5.8	5.1	0.8	-	0.5	0.5	7.7	6.0	46.2	29.1	2.62	2.01
CD (P=0.05)	NS	0.2	0.2	-	0.08	NS	NS	0.3	NS	NS	NS	0.12
Residue management												
No residue added	5.8	5.5	1.0	-	0.4	0.5	7.8	6.4	55.3	39.7	2.94	2.35
All crop residue added	5.8	5.2	1.0	-	0.4	0.5	7.8	6.1	33.2	16.7	1.89	1.41
CD (P=0:05)	NS	NS	NS	-	NS	NS	NS	0.4	9.8	4.2	0.32	0.15
Cropping systems												
Maize – Chickpea system	6.2	5.1	-	-	-	-	8.7	5.1	51.7	19.8	2.65	1.69
Maize/pigeonpea system	5.5	5.6	-	-	-	-	7.0	7.4	36.8	36.6	2.18	2.07
CD (P=0.05)	0.7	0.4	-	-	-	-	0.8	0.4	8.3	4.2	0.28	0.13

REFERENCES

Castro Filho, C., Henklain, J.C., Vieira, M.J., and CasãoJr, R. 1991. Tillage methods and soil and water conservation in southern Brazil. *Soil and Tillage Research* **20**: 271–283

Lal, R. 2010. A dual response of conservation agriculture to climate change: reducing CO2 emissions and improving the soil carbon sink. Opening address, European congress on conservation agriculture. Madrid. *http://www.marm.gob.es/es/ministerio/servicios-generales/publicaciones/Opening_address_tcm7-158494.pdf*