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Tillage management strategy in fodder-food cropping system for sustainable production

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Introduction

The per capita availability of land is consistently decreasing, while food and fodder demand is increasing. Indiscriminate and injudicious use of farm inputs for achieving potential yield of crops has not only enhanced the cost of cultivation but also threatened the environment and sustainability of the system. Combination of these factors and their interface are serious threats to agriculture and mankind. In rainfed condition of central India, fodder sorghum+cowpea –wheat is potential cropping system among farmers maintaining 2-4 livestock's. The conventional tillage system which inverts and mixes the soil, introduces large amounts of oxygen into the soil and thus stimulates aerobic micro-organisms. Use of no till system in agriculture also reduces the rate of soil organic matter loss (Doran and Smith, 1987). There is lower labor, energy, and machinery costs associated with no-till farming relative to conventional tillage systems (Uri, 2000). In view of escalating energy cost and associated ill effects of conventional tillage practices, it is become imperative to optimize tillage requirement of fodder – food cropping system.

Materials and Methods

Field study was conducted during *Kharif* 2009 to *Rabi* 2013 at Central Research Farm, IGFRI Jhansi. The soil was clay loam in texture, medium in organic carbon (0.67 % in 0-15 cm soil depth and 0.42 % in 15-30 cm soil depth) and available phosphorus (21.97 kg/ha), low in available nitrogen (257.5 kg/ha) and high in available potassium (280.3 kg/ha) and neutral in reaction (7.05).Nine tillage rotation for kharif and *Rabi viz*., CT-CT: Conventional tillage (*Kharif*, K)-Conventional tillage (*Rabi*, R), CT-MT: Conventional tillage (K)-Minimum tillage (R), CT-ZT: Conventional tillage (K)-Zero tillage (R), MT-CT: Minimum tillage (K)-Conventional tillage (R), MT-MT: Minimum tillage (K)-Minimum tillage (R), MT-ZT: Minimum tillage (K)-Zero tillage (R), ZT-CT: Zero tillage (K)-Conventional tillage (R), ZT-MT: Zero tillage (K)-Minimum tillage (R) and ZT-ZT: Zero tillage (K)-Zero tillage (R) and two summer ploughing levels viz., NST: No summer ploughing and AST: Alternate year summer ploughing were taken in strip plot design with three replications. Fodder sorghum and cowpea in 2:2 row ratio with row to row spacing of 30 cm and *Duram* wheat with row to row spacing of 20 cm were sown with tractor driven ferti-cum-seed drill. To control the weeds of previous crop (season) in zero tilled plots, non-selective herbicide glyphosate was applied 10±2 days before the sowing of succeeding crop. Wheat equivalent yield (WEY) and returns were worked out using prevailing green fodder, wheat grain and straw price. WEY=Yield of respective crop x Prevaling unit price of crop/ Prevaling unit price of wheat grain

Results and Discussion

From mean data of 4 years field study it was observed that wheat equivalent yield (WEY) of fodder sorghum + cowpea – wheat cropping system did not differ significantly due to tillage management rotation in kharif and *Rabi* season and Summer ploughing (Table 1). Alam *et al*., 2014 also reported similar results in Wheat – Mungbean - Rice cropping system under subtropical climatic conditions. Conventional tillage during *Kharif* and conventional tillage during *Rabi* season (CT-CT) required maximum cost (Rs. 36498/ha) of cultivation than rest of the treatments and minimum cost of cultivation was required by the treatment having minimum tillage during *Kharif* and zero tillage during *Rabi* season. In case of gross return, maximum gross return (Rs. 101558/ha) was recorded with the treatment having conventional tillage during kharif season and minimum tillage during *Rabi* season, however, maximum net return (Rs. 67226/ha) was obtained under minimum tillage during *Kharif* season and minimum tillage during *Rabi* season. The B:C ratio was higher (2.0) under the treatment minimum tillage during *Kharif* season + minimum tillage during *Rabi* season, and minimum tillage during *Kharif* season + zero tillage during *Rabi* season.

Table 1: Effect of tillage practices on wheat equivalent yield (WEY) and soil health in fodder sorghum + cowpea –wheat cropping system

Tillage management practices	Wheat equivalent yield (q/ha)	Soil Health		
		BD (gm/cc)	OC, % in 0-15 cm soil depth	OC, % in 15- 30 cm soil depth
A) Kharif – Rabi Tillage				
Conventional tillage – Conventional tillage	91.3	1.17	0.71	0.41
Conventional tillage – Minimum tillage	93.8	1.17	0.79	0.42
Conventional tillage – Zero tillage	92.9	1.17	0.82	0.43
Minimum tillage – Conventional tillage	86.7	1.19	0.77	0.42
Minimum tillage – Minimum tillage	91.9	1.18	0.81	0.43
Minimum tillage – Zero tillage	90.0	1.18	0.81	0.42
Zero tillage – Conventional tillage	89.3	1.18	0.77	0.44
Zero tillage – Minimum tillage	89.8	1.21	0.81	0.43
Zero tillage– Zero tillage	88.9	1.21	0.83	0.44
CD at 5%	NS	0.01	0.06	0.01
B) Summer ploughing				
No summer tillage	89.6	1.19	0.82	0.43
Alternate year S tillage	91.4	1.18	0.76	0.42
CD at 5%	NS	NS	0.03	NS
Initial value		1.22	0.67	0.42

After completion of 4th year of experimentation, soil samples were taken to study the impact of different tillage management practices on various parameters of soil health (Table 1). Conventional tillage during kharif based tillage management practices recorded significantly lower bulk density (1.17 g/cc) and zero tillage during kharif season + minimum tillage/zero tillage during *Rabi* season recorded significantly higher bulk density (1.21 g/cc). Soil organic matter content in 0-15 cm soil depth was significantly affected by tillage management practices (Table 1). Among various tillage management practices of *Kharif – Rabi* season, it was observed that zero tillage during *Kharif* + zero tillage during *Rabi* recorded significantly higher OC (0.83 %) than continuous conventional tillage practice (0.71 %), however was at par with rest of the treatments. Similarly, OC content in 15-30 cm soil depth also showed similar trend. In case of summer ploughing treatments, alternate year summer ploughing treatment recorded significantly lower organic carbon content (0.76 %) than no summer ploughing (0.82 %) in the soil layer 0-15 cm. In lower layer of soil (15-30 cm), soil organic matter content remained unaffected due to summer ploughing treatments. Radehe and Berry, (1993) stated that the SOC content in top layer of no till soils and reduced soil disturbance promotes greater population of earthworms.

Conclusion

It may be concluded that for sustainable crop production, higher net return and B:C ratio and improved soil health of fodder sorghum + cowpea – duram wheat cropping system grown under minimum tillage (one harrowing followed by one cultivator and planking) during *Kharif* -Minimum tillage (one harrowing followed by one cultivator and planking) or Zero tillage (direct seeding with the help of zero till seed drill and previous crop weeds are managed with the help of non-selective herbicides) during *Rabi* season can be followed for optimum sustainable productivity.

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