Journal of Biotechnology and Crop Science
Vol. 10, No. 15, January-December, 2022, 150-161

doi: 10.5958/2582-5089.2022.00018.4

Research Article

Impact of conservation agriculture practice on biodiversity of soil mesofauna in Mustard - Black gram - Rice cropping sequence under Gangetic basin of West Bengal

Shamik Dey

ABSTRACT

The present experiment was carried out at Balindi Research Complex Farm, Bidhan Chandra Krishi Viswavidyalaya during 2018-2019 and 2019-2020. The field was divided into three tillage systems viz. Conventional tillage (CT), Zero tillage (ZT) and Reduced tillage (RT). Each tillage plot was further subdivided into five different nutrient residue combinations. The cropping system Mustard – Black gram – Rice was selected for the present study. It was found that highest bio diversity value of soil mesofauna (1.63) and (1.68) was obtained from the treatment Zero tillage with 50% paddy straw residue + 75% N.P.K. during both the experimental period 2019 and 2020. In Mustard, diversity value of soil mesofauna (1.69) and (1.71) was highest in Reduced tillage with 50% paddy straw residue + 75% N.P.K. during 2018-2019 and 2019-2020. From Black gram, maximum mesofauna diversity value (1.74) was recorded from Reduced tillage with 50% paddy straw residue + 100% N.P.K and Zero tillage with 100% paddy straw residue + 75% N.P.K during 2019 and 2020.

Keywords: Biodiversity, conservation-agriculture, mesofauna, tillage

INTRODUCTION

Global agriculture is now facing a tremendous challenge and adversely affecting the food and nutritional security among the people. Intensive agricultural practices and indiscriminate application of external inputs are playing the leading role of significant depletion of soil, water, environment, genetic resources and drastically affecting the overall agricultural production and productivity (Brown, 2008; Paroda, 2009). Extensive destruction of natural resources is now posing a serious threat to meet the increasing demand for food, fodder and fibre. Wide spread occurrence of soil erosion, nutrient loss, depletion of ground water table and eroding the biodiversity are attaining the global concern which are seriously affecting the food and nutritional security and livelihood opportunities of the farmers. Application of conventional agriculture leads to soil degradation and loss of natural resources which has considered as the most serious environmental problems (Lal, 2004; Vliek, 2008).

In this context, the entire environmental issues are well addressed through the adoption of conservation agricultural practices. Conservation agriculture is defined as resource saving agricultural practices that help in maintenance of minimum soil disturbance, permanent soil cover and diversification of plant species. It also enhances biodiversity, water and nutrient use efficiency and reduces the chance of pest infestation in the crop (FAO, 2008; 2010; Pretty, 2008). Conservation agriculture production systems are now increasing interest in most of the countries around the globe due to its benefits in conservation of natural resources. No tillage or minimum tillage is now being adopted by the farmers from the Arctic Circle (e.g., Finland) over the tropics (e.g., Kenya,

Shamik Dey

School of Agricultural Sciences, JIS University, Agarpara, Kolkata-700109, West Bengal, India
Email: deyshamik93@gmail.com

Uganda) to about 50º latitude south (e.g., Malvinas/ Falkland Island). From sea level in several countries of the world to 3000 m altitude (e.g., Colombia), from extremely dry conditions with 250 mm a year (e.g., Western Australia), to extremely rainy areas with 2000 mm (e.g., Brazil) or 3000 mm a year (e.g., Chile) (Derpsch & Friedrich, 2009). Globally conservation agriculture is practiced about 125 M-ha cultivated area. The major conservation agriculture practicing countries are United States of America (26.5 M-ha) followed by Brazil (25.5 M-ha), Argentina (25.5 M ha), Canada (13.5 M-ha) and Australia (17 M-ha). Globally it has been estimated that about 84 per cent of total zero-tillage agriculture is now practiced in USA followed by Brazil, Argentina, Canada and Australia. In United States of America, it has been found that about 22.6 to 25 per cent of all crop lands are under the zero-tillage system (Derpsch, 2007). Zero tillage agriculture is also very popular in Latin American countries. Brazil and Argentina, about 60 per cent and in Paraguay about 65 per cent of entire cultivated area practicing the zero-tillage agriculture system. In India, adoption of conservation agriculture is still in its initial phase. Over the past few years, adoption of zero tillage and conservation agriculture has expanded to cover about 1.5 Mha area (Jat et al., 2009). Conservation agricultural system mainly stands with the three basic principles viz. 1) Minimum soil disturbance; 2) Permanent soil cover and 3) Diversified crop rotation.

Minimum soil disturbance

Soil disturbance can be minimized through the adoption of zero tillage and reduced tillage operation. Zero tillage significantly improves the soil health condition, soil fertility status and water holding capacity of soil (Li et al., 2007). Application of zero tillage augment the biodiversity of many beneficial soil fauna which helps in increasing of soil fertility and showing predation activity against many soil borne insect pests and pathogens (Hobbs et al., 2008).

Permanent soil cover

Soil covering or mulching is done through the retention of crop residues which helps in maintenance of optimum soil temperature and soil moisture which ultimately favour the growth and development of many soil organisms (Miguel et al., 2011; Farooq & Nawaz, 2014). Mulching is beneficial in term of reduction of weed problem in crop fields (Thierfelder & Wall, 2009).

Diversified crop rotation

Adoption of crop rotation system helps to break the continuous cycle of many plant pathogens (fungi, bacteria, nematode) and insect pests (Fischer et al., 2002). Crop rotation by growing the pulse crop helps to revitalize the soil fertility status, suppress the growth of weed flora and reduce the chance of soil erosion (Linden et al., 2000; Yadav, 2004).

The benefits of adoption of conservation agricultural practices are very significant in terms of conservation of natural resources. Practicing of conservation agriculture improves the soil health, soil fertility, soil physical property, water holding capacity of soil, organic carbon content of soil (Lal, 1976). Besides it helps in increasing the crop productivity by suppressing the growth of weed flora, breaking the pest life cycle and maintaining the optimum soil moisture and temperature (Farooq et al., 2011). Species diversity of beneficial soil fauna (micro fauna, meso fauna and macro fauna) has been significantly increased through the adoption of conservation agriculture practices and they are responsible for breaking the organic matter and release the essential nutrients in plant (Subias et al., 2012).

Conservation agriculture practices are the most promising future of development of sustainable agriculture throughout the globe. There are lots of potential benefits of conservation agriculture across the diverse agro-ecological zones and farmers groups. The most advantage of this technology is easy adaptability among the different heterogeneous agro-ecological and socio-economic environment (Jat et al., 2009). Due to having different challenges in conventional agriculture system, there is a need of development of a mission mode program for successful promotion of conservation agriculture to upsurge and sustain agricultural production system and increase the income of small and marginal farmers in developing countries and make them more competitive during the time of rapid integration of global market (Singh & Meena, 2013). In Indian context, the concept of conservation agriculture still in initiative phase and it is required to integrate with different government programs with involvement of policy advisors, professionals and financial institutions. The benefits of conservation agriculture system need to be effectively linked to all the stakeholders for its national and international level adoption by the farming community (Lal, 2001; Meena et al., 2010).

MATERIAL AND METHODS

Location of the study

The study was conducted at Balindi Research Complex (BRC), Bidhan Chandra Krishi Viswavidyalaya, West Bengal, India, Latitude 22°95'N and 88°52', Altitude of 10 m above mean sea level (MSL).

Land preparation

The entire field was divided into three tillage plots viz. Conventional tillage (CT), Zero tillage (ZT) and Reduced tillage (RT) depending on the tillage intensity. Conventional tillage plots were prepared by giving the primary tillage with a tractor-drawn disc plough followed by two passes of rigid-tyne cultivator and rotary tiller as secondary tillage to have an excellent tilt and uniform seed-bed. The plots for the reduced tillage were established after sequential tillage operations with two passes of wide Tyne cultivator and two passes of offset disc harrow.

Treatment details and layout of the experimental plot

The entire field was divided into three tillage plots and each tillage plot further subdivided into five subplots (size 20 x 6.3 m²) with application of N.P.K. fertilizers at their recommended dose and retention of paddy straw residue

Table 1: Tillage plots and nutrient-residue combination

Tillage	Nutrient-residue combination
Conventional tillage (CT)	CN1: 0% paddy straw residue + 100% N.P.K
Cropping system:	CN2: 100% paddy straw residue + 50% N.P.K
Mustard – Black gram – Rice	CN3: 100% paddy straw residue + 75% N.P.K
	CN4: 50% paddy straw residue + 100% N.P.K
	CN5: 50% paddy straw residue + 75% N.P.K
Zero tillage (ZT)	ZN1: 0% paddy straw residue + 100% N.P.K
Mustard – Black gram – Rice	ZN2: 100% paddy straw residue + 50% N.P.K
	ZN3: 100% paddy straw residue + 75% N.P.K
	ZN4: 50% paddy straw residue + 100% N.P.K
	ZN5: 50% paddy straw residue + 75% N.P.K
Reduced tillage (RT)	RN1: 0% paddy straw residue + 100% N.P.K
Mustard – Black gram – Rice	RN2: 100% paddy straw residue + 50% N.P.K
	RN3: 100% paddy straw residue + 75% N.P.K
	RN4: 50% paddy straw residue + 100% N.P.K
	RN5: 50% paddy straw residue + 75% N.P.K

at different percentage level (Table 1). The cropping system Mustard (*Rabi*) – Black gram (*Pre kharif*) - Rice (*Kharif*) and single variety of each crop was taken for the experiment during 2018-2019 and 2019-2020.

NPK Ratio used

Crop information

Second cropping system: **Mustard – Black gram - Rice**

In this cropping system B9 variety of mustard was sown on 09.11.2018 and 12.12.2019 with

recommended dose of fertilizer was used as 80:40:40, $N:P_2O_5:K_2O$ kg ha^{-1}

The black gram variety Sarada was sown on 15.02.2019 and 10.03.2020 with

recommended dose of fertilizer: 20:40:40 $N:P_2O_5:K_2O$ kg ha^{-1}

However the Variety of Rice: Ajit (IET 22066) variety of rice was used in the experiment which was sown on 10.06.2019 and 26.06.2020 with recommended dose of fertilizer: 80:40:40 $N:P_2O_5:K_2O$ kg ha^{-1}

Collection of soil mesofauna and study of biodiversity of soil mesofauna

Four different groups of soil mesofauna viz. soil mite, collembola, protura and soil spider was collected from the three tillage systems with the five different nutrient residue combinations under three cropping systems. For extraction of soil mesofauna, rhizospheric soil (100 gm) was collected in a polythene bag at 7 days interval of different days after sowing (DAS) from each of the crop and extraction mesofauna was done by using the Tullgren funnel or Berlese funnel. This funnel was originally developed by Italian Entomologist Berlese and later modified by Tullgren, who used a light bulb as a source of heat. The collected soil samples were kept in the funnel under the light for 24 hours. The light source is useful for providing the heat and soil mesofauna were collected in the test tube set under the funnel containing 70% alcohol. After collection, preliminary identification was conducted in a stereo zoom microscope and counting of mesofauna was carried out per 100 g of rhizospheric soil. Biodiversity study of soil mesofauna was carried out by using Shannon Weiner index.

Shannon wiener index

Shannon Wiener index is a diversity index which was used to calculate the diversity of different organisms and different species of an organisms in a particular area (Shannon & Norbert, 1949). The value of this index ranges from 0-5. The higher value indicates maximum diversity whereas, lower value indicates minimum diversity. The formula of Shannon Wiener index (**H×**) is:

$$\mathbf{H\times} = -\sum_{i=1}^{R} pi ln pi$$

RESULTS

Biodiversity of soil mesofauna under conservation agriculture practices

Soil mesofauna are the soil inhabiting organism with body size in the range between 0.1 mm - 2 mm. In the present study four different groups of soil mesofauna viz. soil mites, collembola, protura and spiders have been recorded and their biodiversity were studied under conservation agricultural practices by using Shannon-Wiener Index during 2018-2019 and 2019-2020.

Cropping sequence: Mustard – Black gram - Rice

In mustard, among the fifteen treatments, maximum value of Shannon-Wiener Index (1.69) was obtained from the treatment RN3 (reduced tillage with 100 % paddy straw residue + 75 % N.P.K) and RN5 (reduced tillage with 50 % paddy straw residue+ 75 % N.P.K) during 2018-2019 and (1.71) from RN5 (reduced tillage with 50 % paddy straw residue+ 75 % N.P.K) during 2019-2020, whereas lowest value (1.41) was obtained from

Table 1: Biodiversity of soil mesofauna in different treatments of conservation agricultural practices of wheat crop under mustard-black gram-rice cropping sequence during 2018-2019 and 2019-2020

Crop: Mustard (*Brassica campestris*)		
Treatments	**Value of Shannon – Wiener diversity index**	
	2018-2019	**2019-2020**
CN1: Conventional tillage with 0% rice residue + 100% recommended dose of N.P.K	1.41	1.41
CN2: Conventional tillage with 100% rice residue + 50% recommended dose of N.P.K	1.50	1.50
CN3: Conventional tillage with 100% rice residue + 75% recommended dose of N.P.K	1.54	1.5
CN4: Conventional tillage with 50% rice residue + 100% recommended dose of N.P.K	1.52	1.48
CN5: Conventional tillage with 50% rice residue + 75% recommended dose of N.P.K	1.42	1.39
ZN1: Zero tillage with 0% rice residue + 100% recommended dose of N.P.K	1.48	1.49
ZN2: Zero tillage with 100% rice residue + 50% recommended dose of N.P.K	1.52	1.57
ZN3: Zero tillage with 100% rice residue + 75% recommended dose of N.P.K	1.54	1.54
ZN4: Zero tillage with 50% rice residue + 100% recommended dose of N.P.K	1.49	1.51
ZN5: Conventional tillage with 50% rice residue + 75% recommended dose of N.P.K	1.53	1.60
RN1: Reduced tillage with 0% rice residue + 100% recommended dose of N.P.K	1.59	1.65
RN2: Reduced tillage with 100% rice residue + 50% recommended dose of N.P.K	1.64	1.67
RN3: Reduced tillage with 100% rice residue + 75% recommended dose of N.P.K	1.69	1.7
RN4: Reduced tillage with 50% rice residue + 100% recommended dose of N.P.K	1.61	1.66
RN5: Reduced tillage with 50% rice residue + 75% recommended dose of N.P.K	1.69	1.71

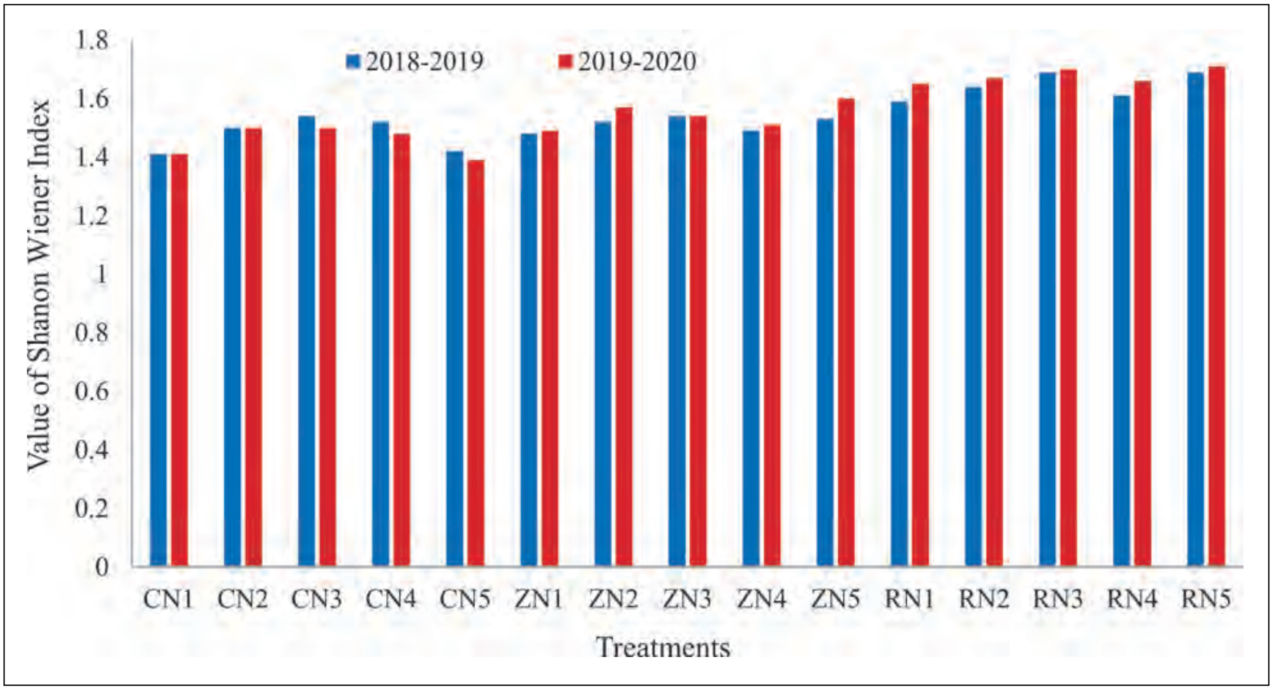

Figure 1: Biodiversity of soil mesofauna in different treatments of mustard crop

Table 2: Biodiversity of soil mesofauna in different tillage of conservation agricultural practices of wheat crop under mustard-black gram-rice cropping sequence during 2018-2019 and 2019-2020

Crop: Mustard (*Brassica campestris*)		
Tillage	**Value of Shannon – Wiener diversity index**	
	2018-2019	**2019-2020**
CT: Conventional tillage	1.47	1.45
ZT: Zero tillage	1.51	1.54
RT: Reduced tillage	1.64	1.67

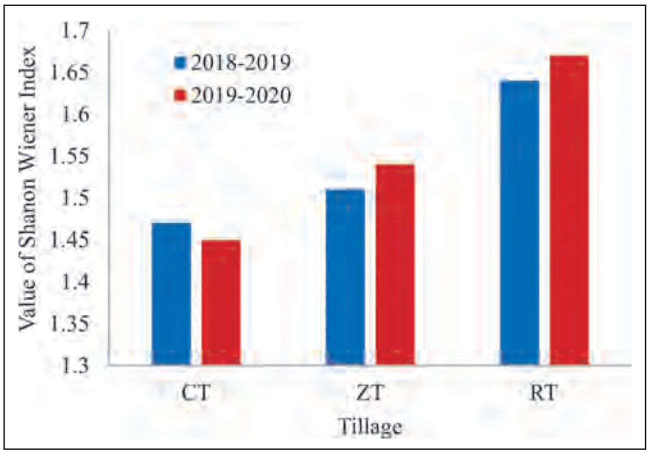

Figure 2: Biodiversity of soil mesofauna in three different tillage systems of mustard crop

CN1 (conventional tillage with 0 % paddy straw residue + 100 % N.P.K) during 2018-2019 and 2019-2020 (Table 1). In view of the impact of three different tillage systems (conventional tillage, zero tillage and reduced tillage) on biodiversity on soil mesofauna, the conventional tillage (CT) resulted lowest biodiversity (1.47) and (1.45) whereas, reduced tillage (RT) showed the maximum (1.64) and (1.67) during both the years (Table 2).

In black gram, out of the fifteen treatments, maximum value of Shannon-Wiener Index (1.74) was recorded from the treatment RN4 (reduced tillage with 50% paddy straw residue + 100% N.P.K) followed by (1.72) from RN3 (reduced tillage with 100% paddy straw residue + 75 % N.P.K) during 2018-2019 and (1.74) from RN3 (reduced tillage with 100% paddy straw residue + 75 % N.P.K) during 2019-2020, whereas lowest value (1.48) and (1.45) was obtained from CN5 (conventional tillage with 50% paddy straw residue + 75% N.P.K) during 2018-2019 and 2019-2020 (Table 3). Out of three different tillage systems (conventional tillage, zero tillage and reduced tillage) on biodiversity on soil mesofauna, that the conventional tillage (CT) system showed lowest biodiversity 1.57 and 1.54 whereas, reduced tillage (RT) showed the maximum diversity 1.66 and 1.69 during both the years (Table 4).

In rice cropping system, among the fifteen treatments, ZN5 (zero tillage with 50% paddy straw residue+ 75% N.P.K) followed by ZN4 (zero tillage with 50% paddy straw residue + 100% N.P.K) yield the best result in terms of providing the maximum value of Shannon-Wiener Index 1.70 and 1.65 and lowest value 1.47 was obtained from CN1 (conventional tillage with 0 % paddy straw residue + 100% N.P.K) during 2018-2019 and 2019-2020 (Table 5). Considering the impact of three different tillage systems on biodiversity on soil mesofauna, it was recorded that conventional tillage (CT) resulted lowest biodiversity of 1.49 and 1.47, whereas, zero tillage (RT) showed the maximum 1.62 and 1.63 followed by reduced tillage 1.57 and 1.60 during both of the years, 2018-2019 and 2019-2020, respectively (Table 6).

DISCUSSION

Biodiversity of soil mesofauna was recorded from fifteen different treatments under conservation agricultural practices from three cropping systems (Maize – Cowpea – Rice; Mustard – Black gram – Rice and Wheat – Green gram – Rice) during 2018-2019 and 2019-2020. Over the course of the study, it has been observed that, biodiversity (value of Shannon Wiener index) of soil mesofauna (soil mite, collembola, protura and soil spider) was high in zero tillage and reduced tillage compared to conventional tillage system and this result was confirmatory with the findings of earlier workers (Winter

Table 3: Biodiversity of soil mesofauna in different treatments of conservation agricultural practices of green gram crop under mustard-black gram-rice cropping sequence during 2019 and 2020

Crop: Black gram (*Vigna mungo*)		
Treatments	**Value of Shannon – Wiener diversity index**	
	2019	**2020**
CN1: Conventional tillage with 0% rice residue + 100% recommended dose of N.P.K	1.62	1.61
CN2: Conventional tillage with 100% rice residue + 50% recommended dose of N.P.K	1.55	1.5
CN3: Conventional tillage with 100% rice residue + 75% recommended dose of N.P.K	1.64	1.6
CN4: Conventional tillage with 50% rice residue + 100% recommended dose of N.P.K	1.59	1.56
CN5: Conventional tillage with 50% rice residue + 75% recommended dose of N.P.K	1.48	1.45
ZN1: Zero tillage with 0% rice residue + 100% recommended dose of N.P.K	1.59	1.61
ZN2: Zero tillage with 100% rice residue + 50% recommended dose of N.P.K	1.64	1.68
ZN3: Zero tillage with 100% rice residue + 75% recommended dose of N.P.K	1.7	1.74
ZN4: Zero tillage with 50% rice residue + 100% recommended dose of N.P.K	1.61	1.63
ZN5: Conventional tillage with 50% rice residue + 75% recommended dose of N.P.K	1.58	1.6
RN1: Reduced tillage with 0% rice residue + 100% recommended dose of N.P.K	1.63	1.66
RN2: Reduced tillage with 100% rice residue + 50% recommended dose of N.P.K	1.6	1.64
RN3: Reduced tillage with 100% rice residue + 75% recommended dose of N.P.K	1.72	1.74
RN4: Reduced tillage with 50% rice residue + 100% recommended dose of N.P.K	1.74	1.73
RN5: Reduced tillage with 50% rice residue + 75% recommended dose of N.P.K	1.65	1.69

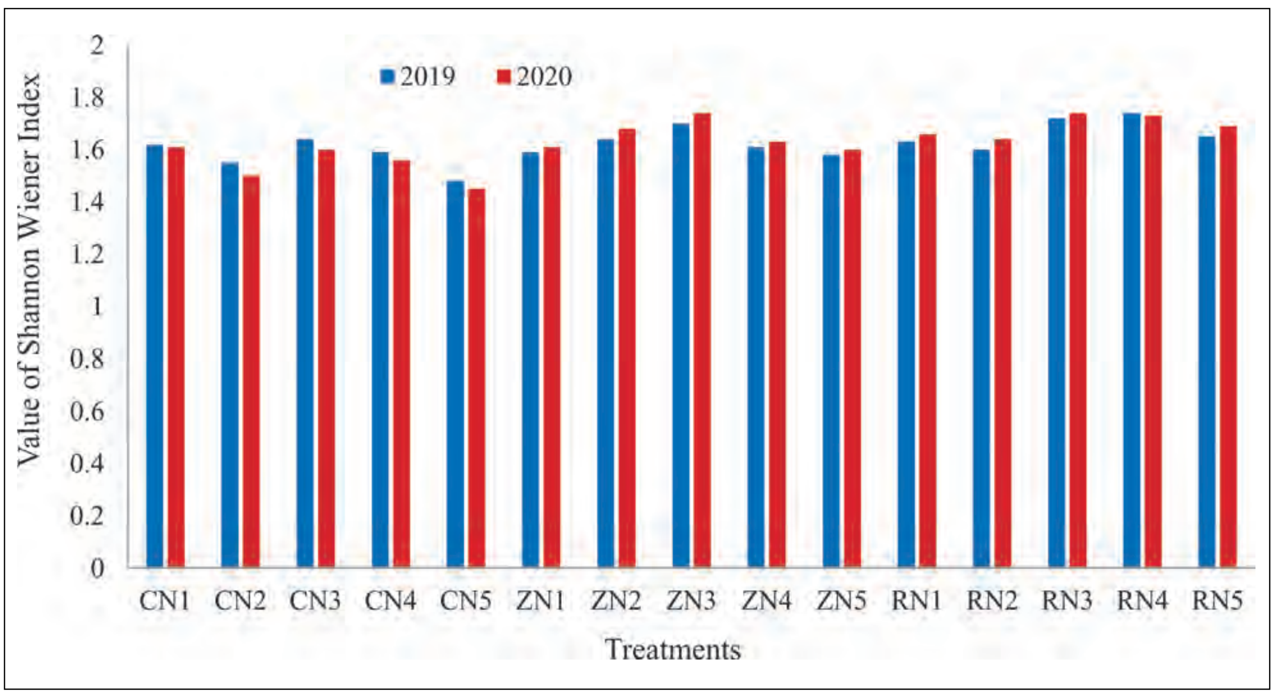

Figure 3: Biodiversity of soil mesofauna in different treatments of Black gram crop

Table 4: Biodiversity of soil mesofauna in different tillage of conservation agricultural practices of green gram crop under mustard-black gram-rice cropping sequence during 2019 and 2020

Crop: Black gram (*Vigna mungo*)		
Tillage	**Value of Shannon - Wiener diversity index**	
	2019	**2020**
CT: Conventional tillage	1.57	1.54
ZT: Zero tillage	1.62	1.65
RT: Reduced tillage	1.66	1.69

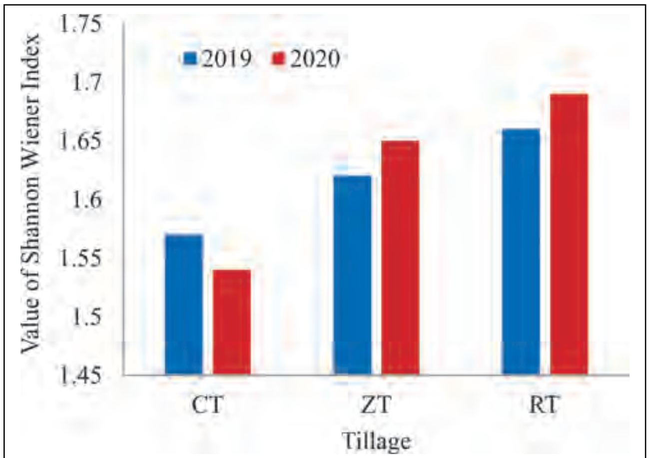

Figure 4: Biodiversity of soil mesofauna in three different tillage systems of Black gram crop

et al., 1990; Garrett et al., 2001; Cortet et al., 2002; Borah & Kakati, 2013; Guru et al., 2015; Zagatto et al., 2017). They concluded that, soil mesofauna have been shown very much sensitive with the intensity of tillage whereas, minimum soil tillage enhances the soil physical and chemical properties which ultimately help to increase the biodiversity of soil mesofauna community. Soil mesofauna play the crucial role in biodegradation process, soil organic matter incorporation, soil aggregation and humification of organic residues (Bossuyt et al., 2005; Coq et al., 2007; Fonte et al., 2009; Brussaard, 2012). According to the study conducted by Anderen & Langerlof (1983); Begum (2013); Sahar & Ahmad (2013), diversity and abundance of soil mesofauna was negatively correlated with the intensity of tillage practice.

Implementation of conservation agriculture practices with the retention of crop residues favoured the abundance, increase the biodiversity and long-term sustenance of the soil mesofauna significantly as compared to the conventional tillage system (Ayuke et al., 2009; Rizk & Mikhail, 2013; Kihara et al., 2015; Paul et al., 2015; Ayuke et al., 2019). In the present study it has been noticed that, zero tillage and reduced tillage with the retention of paddy straw residue (100% and 50%) resulted maximum diversity of soil mesofauna than other treatments. According to the study of Simoni et al. (2013), the soil inhabiting arthropod diversity was found maximum in zero tillage compared to conventional tillage in maize cultivation. The above finding is very comparable with the result of the present experiment whereas, highest biodiversity value of soil mesofauna was recorded from Zero tillage 1.49 and 1.51 than conventional tillage 1.39 and 1.38 during both the years in maize cultivation. Conservation agriculture upsurge soil moisture status, soil water holding capacity, assistance in maintaining of soil temperature at an appropriate level, increase soil organic matter (SOM) content and soil organic carbon (SOC) would help in augmentation of the abundance and diversity of soil mesofauna (Badejo & Akinyemiju, 1993; Narula et al., 1996; Kladivko, 2001; Aquino et al., 2008; Zhu et al., 2010; Ramezani & Mossadegh, 2018). In reduced tillage and zero tillage agriculture system, there is an accumulation of soil organic matter and nutrients near the soil surface and this condition favours for enrichment of the soil mesofauna biodiversity (Ayuke et al., 2009; Khiara et al., 2015). Possibly due to the beneficial impact of conservation agricultural practices, higher biodiversity of soil mesofauna was obtained from zero tillage and reduced tillage in the present experimental study during both of the years. Considering the above findings and results of the present experiment, it can be stated that conservation agriculture (zero tillage and reduced tillage) with the retention of paddy straw residue enhances the mesofauna biodiversity than conventional tillage system.

Table 5: Biodiversity of soil mesofauna in different treatments of conservation agricultural practices of rice crop under mustard-black gram-rice cropping sequence during 2019 and 2020

Crop: Rice (*Oryza sativa*)		
Treatments	**Value of Shannon – Wiener diversity index**	
	2019	**2020**
CN1: Conventional tillage with 0% rice residue + 100% recommended dose of N.P.K	1.47	1.47
CN2: Conventional tillage with 100% rice residue + 50% recommended dose of N.P.K	1.51	1.5
CN3: Conventional tillage with 100% rice residue + 75% recommended dose of N.P.K	1.55	1.52
CN4: Conventional tillage with 50% rice residue + 100% recommended dose of N.P.K	1.49	1.48
CN5: Conventional tillage with 50% rice residue + 75% recommended dose of N.P.K	1.44	1.39
ZN1: Zero tillage with 0% rice residue + 100% recommended dose of N.P.K	1.58	1.6
ZN2: Zero tillage with 100% rice residue + 50% recommended dose of N.P.K	1.59	1.61
ZN3: Zero tillage with 100% rice residue + 75% recommended dose of N.P.K	1.61	1.62
ZN4: Zero tillage with 50% rice residue + 100% recommended dose of N.P.K	1.65	1.65
ZN5: Zero tillage with 50% rice residue + 75% recommended dose of N.P.K	1.70	1.71
RN1: Reduced tillage with 0% rice residue + 100% recommended dose of N.P.K	1.52	1.54
RN2: Reduced tillage with 100% rice residue + 50% recommended dose of N.P.K	1.59	1.58
RN3: Zero tillage with 100% rice residue + 75% recommended dose of N.P.K	1.6	1.69
RN4: Zero tillage with 50% rice residue + 100% recommended dose of N.P.K	1.55	1.6
RN5: Conventional tillage with 50% rice residue + 75% recommended dose of N.P.K	1.62	1.61

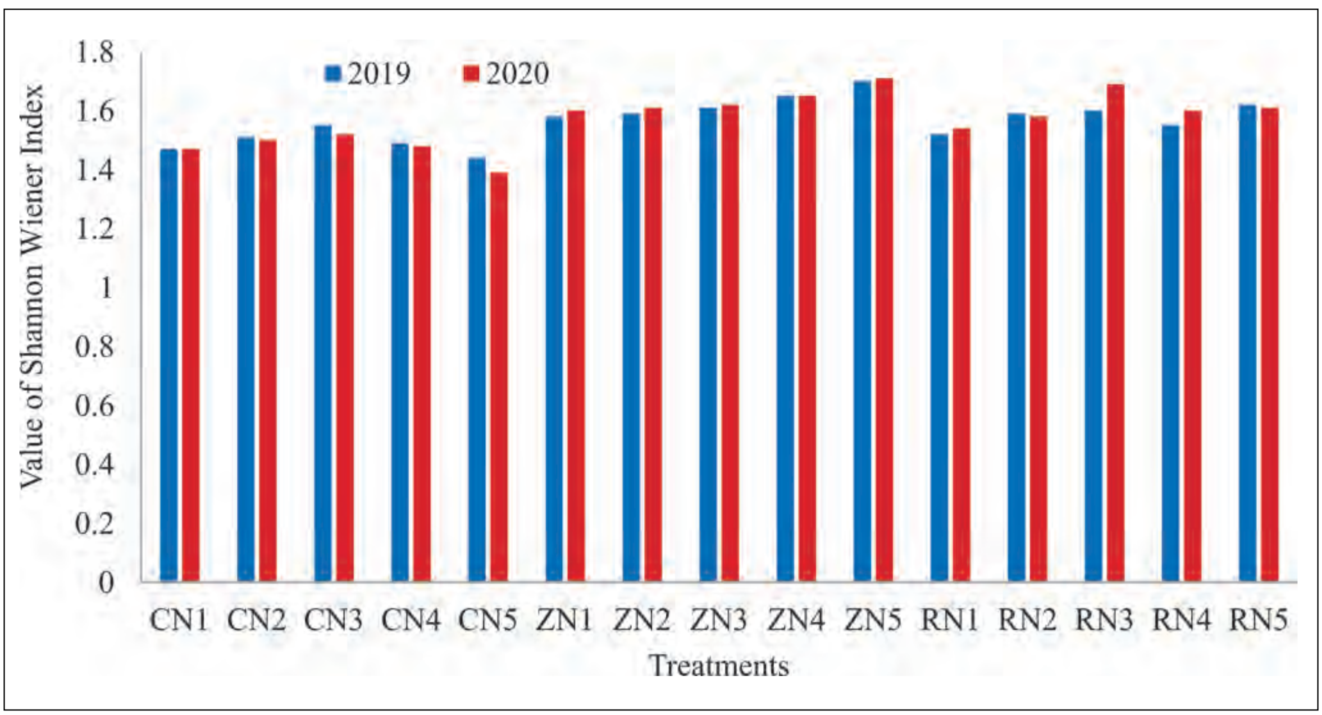

Figure 5: Biodiversity of soil mesofauna in different treatments of Rice crop

Table 6: Biodiversity of soil mesofauna in different tillage of conservation agricultural practices of rice crop under mustard-black gram-rice cropping sequence during 2019 and 2020

Crop: Rice (*Oryza sativa*)		
Tillage	**Value of Shannon-Wiener diversity index**	
	2018-2019	**2019-2020**
CT: Conventional tillage	1.49	1.47
ZT: Zero tillage	1.62	1.63
RT: Reduced tillage	1.57	1.6

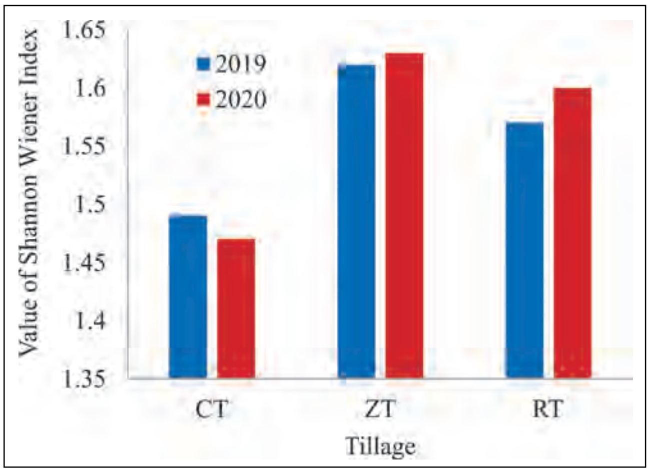

Figure 6: Biodiversity of soil mesofauna in three different tillage systems of Rice crop

CONCLUSION

Conventional tillage practice drastically changes the different soil physical and chemical properties which leads to the destruction of biodiversity of different soil inhabiting mesofauna. Implementation of conservation agriculture results in the augmentation of soil mesofauna diversity by providing the beneficial impact on soil physical and chemical properties. In the present study, it was recorded that zero tillage and reduced tillage with the retention of paddy straw residue increase the diversity of soil mesofauna significantly than the conventional tillage system.

REFERENCES

Anderen, O., & Langerlof, J. (1983). Soil mesofauna (Microarthropods, Enchytraeds, Nematodes) in Swedish agricultural cropping system. *Acta Agriculturae Scandinavica, 33*, 33-52.

Aquino, A.M., Correia, M.E.F., Guimarães, M.F., Lavelle, P., Mercante, F.M., & Silva, R.F. (2008). Invertebrate soil macrofauna under different ground cover plants in the no-till system in the Cerrado. *European Journal of Soil Biology, 44*, 191-197.

Ayuke, F.O., Karanja, N.K., Muya, E.M., Musombi, B.K., Mungatu, J., & Nyamasyo, G.H.N. (2009). Macrofauna diversity and abundance across different land use systems in Embu, Kenya. *Tropical and Subtropical Agroecosystems*, *11*, 371–384.

Ayuke, F.O., Kihara, J., Ayaga, G., & Micheni, A.N. (2019). Conservation agriculture enhances soil fauna richness and abundance in low input systems: examples from Kenya. *Frontiers in Environmental Science, 7*, 1-17.

Badejo, M.A., & Akinyemiju, O.A. (1993). Response of soil mites to hexazinone application in Nigeria. *Science of the Total Environment, 2*, 1156-1159.

Begum, F., Bajracharya, R.M., Sitaula, B.K., Sharma, S., Ali, S., & Ali, H. (2014). Seasonal dynamics and land use effect on soil microarthropods communities in the Mid-hills of Nepal. *International Journal of Agronomy and Agricultural Research, 5*, 114-123.

Borah, M., & Kakati, L.N. (2013). Abundance and distribution of soil Acarina in natural and degraded forest ecosystem at Pathalipam, Lakhimpur, Assam. *International Journal of Scientific and Engineering Research, 4*, 1694-1709.

Bossuyt, H., Six, J., & Hendrix, P.F. (2005). Protection of soil carbon by microaggregates within earthworm casts. *Soil Biology and Biochemistry, 37*, 251-258.

Brown, L. (2008). Introduction in No-Till Farming Systems (Edited by Zoebisch, M.A., Gan, Y.T., Ellis, W., Watson, A. and Sombatpanit, S. Special Publication No 3, World Association of Soil and Water Conservation, Bangkok.

Brussaard, L. (2012). Ecosystem services provided by the soil biota, in soil Ecology and Ecosystem Services, eds D.H. Wall, R.D. Bardgett, V. Behan-Pelletier, J.E. Herrick, T.H. Jones, K. Ritz, J. Six, D.R. Strong and W.H. van der Putten (Oxford, UK: Oxford University Press), pp 45-58.

Coq, S., Barthes, B.G., Oliver, R., Rabary, B., & Blanchart, E. (2007). Earthworm activity affects soil aggregation and organic matter dynamics according to the quality and localization of crop residues – An experimental study (Madagascar). *Soil Biology and Biochemistry, 39*, 2119-2128.

Cortet, J., Ronce, D.N., Poinsot-Balaguer, C., Beaufreton, A., Chabert, P., Viaux, & Paulo Cancela de Fonseca, J. (2002). Impacts of different agricultural practices on the biodiversity of microarthropod communities in arable crop systems. *European Journal of Soil Biology, 38*, 239-244.

Derpsch, R. (2007). Historical Review of no-tillage cultivation of crops. http://www.rolf.-derpsch.com/notill.html.

FAO. (2008). Investing in Sustainable Crop Intensification: The Case for Soil Health. Report of the International Technical Workshop, FAO, Rome, July. *Integrated Crop Management, 6*, Rome: FAO. On WWW at http://www.fao.org/ag/ca/.

FAO. (2010). Analysis of the Status and Potential of Conservation Agriculture in Southern Africa. Johannesburg.

Farooq, M., & Nawaz, A. (2014). Weed dynamics and productivity of wheat in conventional and conservation rice-based cropping systems. *Soil and Tillage Research, 141*, 1-9.

Farooq, M., Flower, K., Jabran, K., Wahid, A., & Siddique, K.H.M. (2011). Crop yield and weed management in rainfed conservation agriculture. *Soil and Tillage Research, 117*, 172-183.

Fischer, R.A., Santiveri, F., & Vidal, E.R. (2002). Crop rotation, tillage and crop residue management for wheat and maize in the sub humid tropical highlands. *Field Crop Research, 79*, 123-137.

Fonte, S.J., Winsome, T., & Six, J. (2009). Earthworm populations in relation to soil organic matter dynamics and management in California tomato cropping systems. *Applied Soil Ecology, 41*, 206-214.

Garrett, C.J., Crossley, D.A., Coleman, D.C., Hendrix, P.F., Kisselle, K.W., & Potter, R.L. (2001). Impact of the rhizosphere on soil microarthropods in agroecosystems on the Georgia piedmont. *Applied Soil Ecology, 16*, 141-148.

Guru, P.N., Patil, R.K., & Hadimani, A. (2015). Impact of Conservation agriculture practices on arthropod community in Cotton intercropping with groundnut system. *International Journal of Tropical Agriculture, 33*, 2499-2508.

Hobbs, R.P., Sayre, K., & Gupta, R. (2008). The role of conservation agriculture in sustainable agriculture. *Philosophical Transactions of the Royal Society* B, *363*, 543-555.

Jat, M.L., Singh, G., Ravi, M.K., Saharawat, V., Gathala, H.S., & Gupta, R. (2009). Innovations Through Conservation Agriculture: Progress and Prospects of Participatory Approach in Indo-Gangetic Plain", in 4th World Congress on Conservation Agriculture held on 4-7 February 2009 in New Delhi, organised by the National Academy of Agricultural Sciences, (Vol. Lead Papers), pp. 60-64.

Kihara, J., Martius, C., & Bationo, A. (2015). Crop residue disappearance and macrofauna activity in sub-humid western Kenya. *Nutrient Cycling in Agroecosystems, 102*, 101–111.

Kladivko, E.J. (2001). Tillage systems and soil ecology. *Soil and Tillage Research, 61*, 61–76.

Lal, R. (1976). No tillage effects on soil properties under different crops in western Nijeria. *Soil Science Society of America, Proceedings, 40*, 762-768.

Lal, R. (2001). Managing world soils for food security and environmental quality. *Advances in Agronomy, 74*, 155-192.

Lal, R. (2004), Soil carbon sequestration impacts on global climate change and food security. *Science 34*, 1623-1627.

Li, H., Gao, H., Wu, H., Li, W., Wang, X., & He, J. (2007). Effects of 15 years of conservation tillage on soil structure and productivity of wheat cultivation in Northern China. *Australian Journal of Soil Research, 45*, 344-350.

Linden, D.R., Clapp, C.E., & Dowdy, R.H. (2000). Long term grain and stover yields as a function of tillage and residue removal in east central Minnesota. *Soil and Tillage Research, 56*, 167-174.

Meena, M.S., Singh, K.M., & Singh, S.S. (2010). Conservation Agriculture: adoption strategies. *Agricultural Extension Review, 22*, 20-24.

Miguel, A.F., Penalva, M., Calegari, A., Derpsch, R., & McDonald, M.J. (2011). Green manure/cover crops and crop rotation in conservation agriculture on small farms. Plant Production and Protection Division, FAO, Rome.

Narula, A., Vatsa, L.K., & Handa, S. (1996). Soil arthropods of a deciduous forest stand. *Indian Journal of Forestry, 19*, 285-288.

Paroda, R.S. (2009). Global Conventions and Partnerships and their Relevance to Conservation Agriculture in 4th World Congress on Conservation Agriculture held on 4-7 February 2009 in New Delhi, organised by the National Academy of Agricultural Sciences (Vol. Lead Papers), pp. 30-35.

Paul, B.K., Vanlauwe, B., Hoogmoed, M., Huriso, T.T., Ndabamenye, T., & Terano, Y. (2015). Exclusion of soil macrofauna did not affect soil quality but increased crop yields in a sub-humid tropical maize-based system. *Agriculture, Ecosystems & Environment, 208*, 75-85.

Pretty, J. (2008). Agricultural sustainability: concepts, principles and evidence. *Philosophical Transactions of the Royal Society of London* B, *363*(1491): 447–466.

Ramezani, L., & Mossadegh, M.S. (2018). Impacts of tillage on biodiversity of microarthropod communities in two different cropping system. *International Journal of Bioengineering and Life Sciences*, *12*, 308-311.

Rizk, M.A., & Mikhail, W.Z.A. (2013). Impact of no-tillage agriculture on soil fauna diversity. *Zoho Middle East*, *18*, 113-120.

Sahar, S., & Ahmad, G.A. (2013). Effect of tillage on soil biodiversity. *Journal of Novel Applied Sciences, 2*, 273-281.

Simoni, S., Nannelli, R., Castagnoli, M., Goggioli, D., Moschini, V., Vazzana, C., Benedettelli, S., & Migliorini, P. (2013). Abundance and biodiversity of soil arthropods in one conventional and two organic fields of Maize in stockless arable systems. *Redia, 96*, 37-44.

Subias, L.S. (2012). Listado de Los Acaros oribatidos de Las Differentes Regions Biogeographicas Del Mundo. Internet updated & actualized in 2014, available from http:// www. Ucm.es/info/zoo/Arthropods/Catalogo.

Thierfelder, C., & Wall, P.C. (2009). Effects of conservation agriculture techniques on infiltration and soil water content in Zambia and Zimbabwe. *Soil and Tillage Research*, *105*, 217-227.

Vliek, L.G. (2008). The incipient threat of land degradation. *Journal of the Indian Society of Soil Science, 56*, 23-35.

Winter, J.P., Voroney, R.P., & Ainsworth, D.A. (1990). Soil microarthopods in long-term no-tillage and conventional tillage corn production. *Canadian Journal of Soil Science*, *70*, 641-653.

Yadav, R.L. (2004). Enhancing efficiency of fertilizer N use in rice-wheat systems of Indo-Gangetic plains by intercropping Sesbania aculeata in direct seeded upland rice for green manuring. *Bioresource Technology, 93*, 213-215.

Zagatto, M.R.G., Junior, L.A.Z., Pereira, A.P., Bonilla, G.E., & Cardoso, E.J. (2017). Soil mesofauna in consolidated land use systems: how management affects soil and litter invertebrates. *Scientia Agricola*, *76*, 165-171.

Zhu, X., Gao, B., Yuan, S., & Hu, Y. (2010). Community structure and seasonal variation of soil arthropods in the forest-steppe ecotone of the mountainous region in Northern Hebei. *China Journal of Mountain Science*, *7*, 187–196.