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Effect of no-tillage and tillage on the ecology of mite, *Acarina* (Oribatida) in two different farming systems of paddy field in Cachar district of Assam

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Abstract

The present investigation was carried out in Cachar district of Assam over a period of one year (January 2011 – December 2011) to understand the seasonal ecology of Acarina (Oribatida) in rice (*Oryza sativa L.*) cultivated fields. Population of Oribatida was found to be maximum during August 2011, both in no-tillage (6.32±0.66 No. /m^2 x 100^2) and tillage (5.30 ± 0.71 No. /m^2 x 100^2) sites in Dorgakona area whereas the peak was recorded during August 2011, both in no-tillage (5.38± 0.75 No./m^2 x 100^2) and tillage (4.69±0.77 No./m^2 x 100^2) in Durby area of study sites. Least population was encountered during January 2011, in both no-tillage (0.98± 0.28 ± No. /m^2 x 100^2) and tillage (0.98±0.30 No./m^2 x 100^2) sites in Dorgakona area whereas the same was found during November 2011 in no-tillage (0.57±0.31 No./m^2 x 100^2) and in February 2011 in tillage (0.45± 0.21 No./m^2 x 100^2) sites of Durby area. Linear regression analysis with all the environmental variables showed positive and significant influence on the population dynamics whereas relative humidity (R^2=0.26 p>0.05) in Dorgakona no-tillage and tillage (R^2=0.19 P>0.05) sites and relative humidity in tillage site (R^2=0.27 P>0.05) in Durby area showed no influence. Multiple regression analysis showed that the combined effect of climatic variables having a significant influence (p<0.05) on the oribatid mite population in no-tillage and tillage systems in both the study sites. Rainfall, relative humidity and temperature facilitated the soil moisture, microbial activity and litter decomposition, which in turn may favour the reproduction and growth rate of the species. Among microclimatic conditions all the parameters showed positive and significant influence (P<0.05) on the population in no-tillage and tillage system on both the sites except pH which showed negative correlation with the population. One way ANOVA revealed significant difference (F=6.53, P<0.01) of the Oribatid population between the systems.

Key words

Climatic variables, Multiple regressions, No-tillage, Oribatid mite, Tillage

Introduction

Among all the soil microarthropods, oribatid mites (Acari: Cryptostigmata) are predominant and play an important role in increasing soil fertility through organic decomposition. Their importance in view of ecology and soil fertility is well established (Heneghan *et al.,* 1998). But in agricultural fields, due to application of different fertilizers and also, by crop rotation, tillage, irrigation etc., the natural oribatid mite population and their ecology are affected. Tillage and manuring of the area disturbs the soil profile. Tillage is a kind of conventional method of ploughing practice in cultivated field where as no-tillage means no intense agricultural manipulation in the agricultural field. Tillage may lead to soil compaction, loss of organic matter and death of soil microarthropods. The changing land use and agricultural intensification has a profound effect on the structure and diversity of the decomposer community (Beare *et al.,* 1997). Soil organisms are subjected to variety of edaphic factors in soil such as soil moisture, temperature, pH, amount of organic carbon and nitrogen content of the soil, which have direct or indirect effect on the population dynamics of soil microarthropods. The population density of these soil microarthropods may have an effect on agricultural produce because they are the vital source of maintaining soil health. An agro-ecosystem is regularly disturbed in the context of the above and below ground species population as well as biomass removal, nutrient input and use of pesticides and herbicides (Neher, 1999). Management system implies alterations on the abundance of arthropod population and natural enemies present in the crop. The harvested crop removes nutrients from the fields each time. Repeated harvesting of the crop makes the soil even poorer in nutrients and organic matter content availability. The loss in soil organic matter content adversely affects soil biodiversity (Adl and Coleman, 2005). The foregoing information clearly establishes that for effective management of soil to optimize its fertility and crop yield a comprehensive knowledge of soil microarthropods along with the effects of various edaphic factors and management practices governing a particular ecosystem is essential. There is a considerable paucity of this information on soil microarthropods of North-eastern part of India. Some progress has been made towards the understanding of the effects of different edaphic factors on the ecology of soil microarthropods in this part of the country (Gope and Ray, 2006; Ray and Gope, 2006; Gope *et al*., 2007; Gope and Ray, 2012). The main objective of this study was to determine if the population of the Oribatid mite changed with Tillage and No-tillage practices in relation to environmental as well as edaphic factors in these two systems of cultivation of the soil.

Materials and Methods

Study sites : The present investigation was carried out in two paddy fields of Cachar district, situated in the valley of River Barak, Assam in Northeastern region of India. One paddy field was situated in Dorgakona village, 2 kms away from University campus whereas the other paddy field was located 30 kms away from the university campus, in Durby area. Each paddy field was divided into two areas in which one portion was applied with conventional tillage meaning ploughing of land method whereas the other portion was left without tillage meaning no ploughing or any agricultural manipulation for the whole one year study period. In tillage system, the field was cultivated with paddy (*Oryza sativa L.*) once in a year during July to November. The climate of both the study sites was subtropical warm and humid with average rainfall 2660 mm (May to September) and maximum temperature from 25.1°C (January) to 32.6°C (August) whereas, minimum temperature ranged from 11°C (January) to 25°C (August). Average relative humidity of the area was 87%.

Soil sampling and extraction of Oribatid mites : Soil samples were regularly collected at monthly intervals for a period of one year (January to December, 2011) from both the study sites between 08.00 to 09.00 hrs. On each sampling occasion, 10 sample units (5 each from no-tillage and tillage systems) were drawn at random with stainless steel soil augur (2.5 cm diameter) at a depth of 10 cm. These samples were immediately transferred to polythene bags and brought to the laboratory in sealed condition. The extraction was done using Tullgren funnel type extractor as modified by Murphy (1962) under 25W electric bulb. The extracted oribatid mites were collected in specimen tube containing 70% ethanol. After identification of major taxonomic unit by face contrast microscope (10x X 100x), all the specimens were preserved in 70% ethanol separately. Soil analyses were done following the standard methods of Allen *et al.* (1989) and Anderson and Ingram, (1993).Population density was calculated for the encountered soil Oribatid mites followed by Singh *et al.* (1978) in MS Office Excel - 2003.

Statistical analysis : Linear regression, multiple regression and analysis of variance (ANOVA) were performed by using the statistical package (version 16, SPSS Ins., Chicago, IL, USA) programme.

Results and Discussion

During the study period, the population was found to be maximum during August 2011, both in no-tillage (6.32±0.66 No. / m^2 x 100^2) and tillage (5.30 ± 0.71 No./m ^{2} x 100^2) systems at Dorgakona study site. Similar pattern of peak population was also recorded during August 2011 both in no-tillage (5.38± 0.75 No.

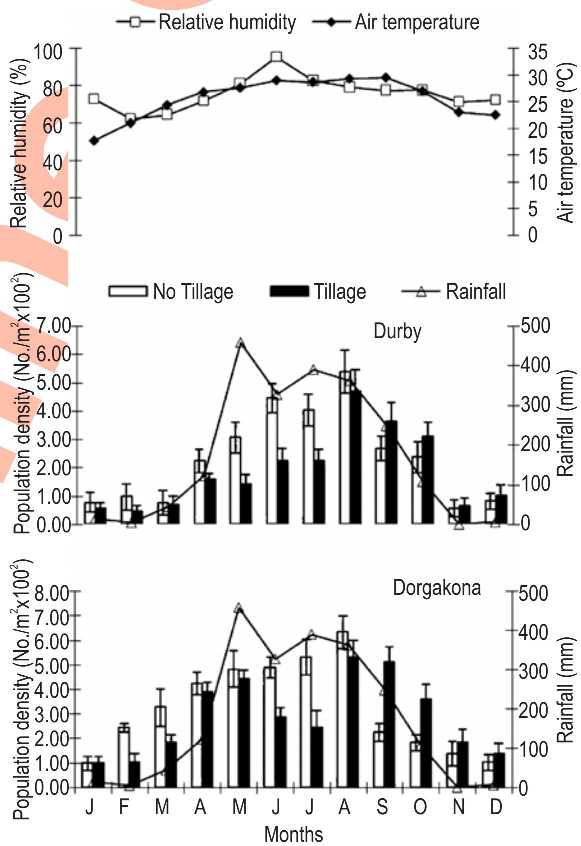

Fig.1: Population dynamics of Oribatid mite in Dorgakona and Durby sites during, 2011 in relation to humidity, temperature and rainfall

/m^2 x 100^2) and tillage (4.69±0.77 No./m^2 x 100^2) systems in Durby area. Least population was encountered during January 2011 in both no-tillage (0.98±0.28 ± No. /m^2 x 100^2) and tillage (0.98±0.30 No./m^2 x 100^2) systems in Dorgakona area, whereas least population was found during November 2011 in no-tillage (0.57±0.31 No./m^2 x 100^2) and in February 2011 in tillage (0.45± 0.21 No./m^2 x 100^2) sites in Durby area. At both the study sites, population density was found to be higher in no-tillage systems than tillage system. But post monsoon period (Sep-Nov) showed an increase in population density in the tillage system than in no-

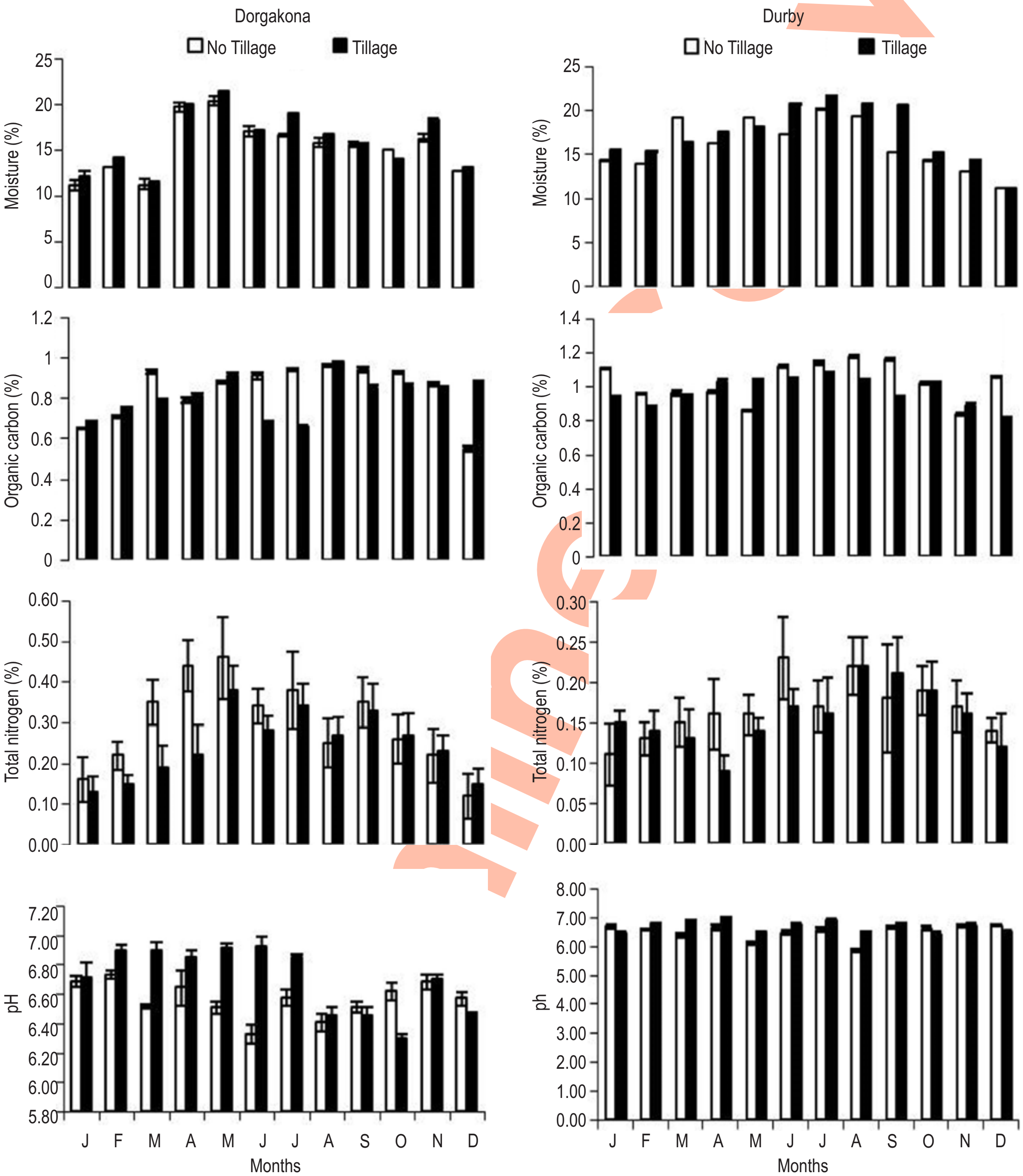

Fig. 2 : Dynamics of soil moisture (A) organic carbon content (B) Total nitrogen (C) and pH (D) over the study period (January 2011 to December 2011)

tillage system at both the sites (Fig.1). It supports the observation of Walia and Mathur (1997), who found high acarine population in September due to favourable soil temperature and moisture conditions. Low population density in tillage system on both the sites during the mid of monsoon seasons (May-July) might be due to high level of water stress and agricultural practices. Banerjee *et al*. (2009) also observed high abundance of population during the post monsoon seasons which might be due to increase in nutrient availability to soil during standing crop period. Here, both linear and multiple regression analyses were employed to established the hypothesis that environmental variables had influence on the population dynamics of Oribatid mites and the results revealed that all the environmental variables showed positive and significant influence on the population dynamics, whereas relative humidity (R^2=0.26 p>0.05) in no-tillage system, tillage system of Dorgakona (R^2=0.19 P>0.05) and tillage system (R^2=0.27 P>0.05) of Durby area did not show any significant influence. The combined effect of all the environmental parameters (rainfall, relative humidity and air temperature) on population density was assessed by multiple regression analysis. Positive and significant influences were reported from both No-tillage (R^2=0.72 p<0.05) and tillage system (R^2=0.72 p<0.05) in Dorgakona area. Similarly, in Durby area also showed positive and significant influences in both no-tillage (R^2=0.84 p<0.01) and tillage system (R^2=0.61 p<0.05). The combined effect of climatic factors showed strong influence on this group of population as supported by Reddy and Ao (1995), where they indicated that these factors were regulating their different vital activities. Low population of Oribatid mite in very wet period might be attributed to their mortality or migrated towards favourable areas.

Relation between soil fauna and physico-chemical properties of soil: The value of moisture content was found to be higher during wet months (June to October) in tillage systems both the investigated sites (Fig. 2A). Soil organic carbon content ranging at 0.55%-0.96%, 0.84%-1.18% and total nitrogen content ranging from 0.12%-0.46%, 0.11%-0.23% at Dorgakona and Durby sites, respectively was higher in no-tillage system throughout the study period (Fig. 2 B,C). The pH values of both the investigated sites did not show much fluctuation but a significant difference was found between the two sites and the values were found to be higher in tillage system than in no-tillage system (Fig. 2D). The soil moisture content exhibited significant correlations with population of both no-tillage and tillage systems except the tillage system of Dorgakona site (R^2=0.26, p>0.05) which corroborates the works of Gope and Ray (2012). The level of moisture content declined during dry months (November to February) due to low rainfall and excessive evaporation of soil water. As a result, the species tended to migrate to higher depths. Since, the present investigated areas are habituated with high precipitation therefore, population may not withstand during the dry period which may lead to mortality of Oribatid mites. Among the chemical parameters, organic carbon and total nitrogen content showed positive and significant relationship with the population except in no-tillage system (R^2=0.30 P>0.05) and tillage system (R^2 =0.28 P>0.05) for organic carbon in Durby site which showed positive but weak correlation with the organic carbon. Here, significant positive correlation between population and soil organic matter and total nitrogen corroborates the findings of Gope and Ray (2006), Tripathi *et al.* (2007) and Ray *et al*. (2012). The highest nutrient concentration of soil during July to October may be attributed to nutrient release during the decomposition process as in this period high temperature, heavy rainfall and high relative humidity influence the high rate of decomposition process. The highest nutrient concentration soil during October to March may be attributed to nutrient release in the decomposition process of straw available after harvesting of rice. The soil pH in the present study did not exhibit a wide range of variation among the investigated sites and its significant influence of it was not recorded on population dynamics. Such observation was earlier reported by Gope and Ray (2012). The pH may have an inhibitory role on the increase of microarthropod population in general and oribatid mite in particular. ANOVA and mean comparison between no-tillage and tillage systems at both the investigated sites showed a significant difference in population (F=6.53 P<0.001). Further, mean comparison between the systems using Tukey test revealed that there was a significant difference in population between no-tillage system of Dorgakona site and the tillage system of Durby site (P<0.01). The study clearly showed that agro-ecosystem with tillage practices had significant influence on the population dynamics of oribatid mites in which their numbers were greatly reduced. However, reduced tillage methods may be recommended as a viable alternative in lieu of conventional tillage methods which will support the oribatid mite population lead to increase the nutrient quality at soil surface in rice cultivation areas.

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