



# Impacts of tillage and no-till on earthworm density and physicochemical properties of soil in Ambedkar Nagar, Uttar Pradesh, India

Prashasti<sup>1</sup>, Pranjali<sup>2</sup>, Satya Prakash Arya<sup>3</sup>, Vishal Kumar Singh<sup>4</sup>, Vijay Kumar<sup>5</sup>

<sup>1,2,3</sup>D.A.V. Academy Ambedkar Nagar

<sup>4</sup>Soil testing laboratory Ambedkar Nagar

<sup>5</sup>Government Degree College Babrala Gunnaur Sambhal

## ABSTRACT:

Earthworms are treated as an important indicator of soil health. They are recycling organic matter, responsible for soil development and one of the important vital components of many food webs. In present study, earthworms were sampled during June 2023 to December 2023 from three villages (Jot Awasthi, Rampur Kalan, Rasoolpur Mubarakpur) of Ambedkar Nagar, Uttar Pradesh India. The samples were collected from conventional tillage (CT) crop fields and no-till (NT) places like orchard, land not in use and land near pond. The density of earthworms was found maximum in No-till sandy soil, soil with high content of organic matter and moisture. Earthworm presence was recorded maximum in fields with pH 7.0 to 7.5 and organic carbon content 0.32 to 0.52 g/kg of soil.

**KEYWORDS:** Earthworm, Conventional tillage, Annelids, Soil, No-till

## INTRODUCTION:

Buckerfield et al., 1997, E. Blanchart et al., 1997 work out the importance of earthworms as biological indicators of soil quality and expressed as an important keynote species. Lee, 1985 shows that earthworms have a positive influence on soil structure, decomposition of litter, mineralization and cycling of nutrients. Their activities in improvement of soil physical and chemical conditions are worked out by Hauser, 1993. Pratik Acharya et al., 2020 performed study in Odisha and concluded that population density of earthworms varies in different seasons. Organic content, moisture, bacterial and fungal presence shows positive correlation with the density of earthworms. J.G. Zaller 1999 successfully correlated the productivity with earthworm density and moisture content. Patrick J. Bohlen et al., 1997 examined how earthworms influence the surface litter decomposition and concluded that earthworms actively control the surface litter decomposition in no-till (NT) land. Subin Kalu et al., 2015 found highest density of earthworm in forest, positive correlation with the mineral nutrients, phosphorus and potassium. The highest earthworm population density was found in forest followed by agriculture land and grassland. Earthworms were found aggregated in 15 cm of soil from top. Moisture and organic matter content were found to be major determinants of earthworm population in Panchase area of Nepal. Positive and significant correlation between earthworm population and available mineral nutrients (P and K) suggests that earthworms help in mineral nutrient availability to the plants.

Manuel Aira et al., 2002 recorded the activity of earthworm in pig manure. Influence of soil properties on density of earthworm was observed by E. Lapiet et al. 2009. They reported that population was low in tilled agricultural soil. The effect of earthworms activity on plant yield has been shown by Waters, 1951. Barley, 1961; Stockdill and Cossens, 1966; Watkin and Wheeler, 1966; Mackay et al., 1983; Curry and Byrne, 1992. Many researches (Edwards and Lofty, 1982, House and Parmelee, 1985, Parmelee et al., 1990, Buckerfield, 1992, Clapperton et al., 1997, Chan, 2001, Emmerling, 2001) around the world have shown that reduced tillage generally favors large population of earthworm. The modern agriculture practices like tillage, use of fertilizers and pesticides attributed to high disturbances, physical injuries, and

susceptibility to predation by birds while no till provide favorable soil environmental conditions (Edwards and Lofty, 1982, Lee, 1985, Chan, 2001). Earthworms also respond to the changes in soil physical properties and environmental conditions (Lavelle et al., 1997).

Growing interest in managing earthworm activity has created a need for further research into the impact of production processes on earthworm populations (Hendrix and Edwards, 2004), The major objective of this study was to determine how earthworm populations and key soil physical and chemical properties relate to one another and how the tillage activity affects earthworm population.

### MATERIAL AND METHODS:

The sampling areas were selected on the basis of survey included conventional tillage (CT) and no till (NT) soil. Samples were collected as suggested by K.I. Peverill, L.A. Sparrow, D.J. Reuter (1999) in his book Soil analysis: an interpretation manual. Earthworm number or biomass in the selected areas was estimated according to the method suggested by A Gunn (1992). Quadrant method was used to calculate the density of earthworms. To quantify earthworm number, the sample was collected from four corners and from the center of the field. A wooden quadrant of 1mx1mx15cm was placed above the soil. Suspension of mustard powder in water in the ratio 50g in 10 liters was poured in the quadrant up to the height of 5cm to collect earthworms. Conventional digging and hand sorting method was also used to find out the density of earth worms and comparison of efficiency of two methods.

### DISCUSSION:

George G. Brown, 2003 and Johnson et. al. 2007 shows that tillage activity decreases the abundance of earthworms while no tillage increases the density and biomass of earthworms. They recorded 46-116 individuals per meter square in no tillage sites, 42-179 individuals per meter square at minimum tillage site and 13-22 individuals per meter square in conventional tillage sites. In our study we observed same impact of tillage and no till. The average number of individuals per meter square at conventional tillage (CT) site is minimum i.e. 0 to 31 individuals per square meter while the average number of individuals per meter square at no till (NT) site is maximum i.e. 91 to 171. In CT sites mean earthworm density was 17.85 individuals per meter square and 137.33 individuals per meter square in NT. The worm casting is an indicator of abundance of earthworms in the soil. We observe abundant worm casting at NT sites. Data also suggest that an adverse soil environmental condition in crop field limits earthworm density. Correlation between the densities of earthworm with soil physical and chemical properties was calculated. Researches shows that earthworms influence a wide range of critical chemical and physical soil properties it is important to understand how their populations are impacted by soil management.

Pearson coefficient of correlation was calculated by online calculator available on statskingdom.com indicated that there is a significant large positive relationship between densities of earthworm and moisture content of soil, Pearson correlation coefficient ( $r$ ) is 0.7898. When earthworm densities correlate with pH of soil, the value of “ $r$ ” is 0.3106 it indicates that there is a non significant medium positive relationship between the two variables. Electrical conductivity, phosphorus content of soil shows non-significant small negative relationship while carbon content, nitrogen content shows non- significant medium positive relationship with earthworm densities. Table- 1 shows that average earthworm densities from No-till sites like orchid, road side and pond edge, densities was observed maximum i.e. 150, 91, 171 per square meter respectively while minimum densities were recorded from the sites where tillage is a regular practice before cultivation of crops.

### ACKNOWLEDGEMENT:

We would like to acknowledge our guide teacher Mr. Satya Prakash Arya for his guidance. Thank you Dr. S K Verma (Ret. Professor and HOD) Department of soil science and agricultural chemistry, R.V.S.K.V.V., Gwalior M.P., and Shyam Mohan (Science teacher) Sarvoday Inter College, Kotwa Muhammadpur, Akbarpur, Ambedkar Nagar for their valuable suggestions and support.



Figure 1: Line fit plot between earthworm density and soil moisture.

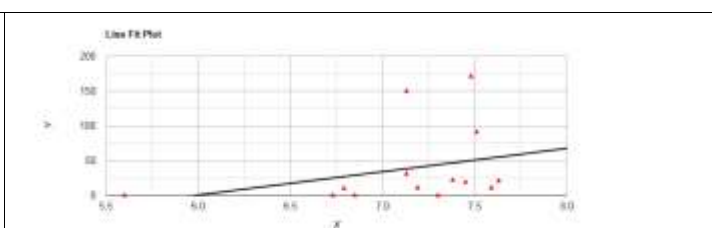


Figure 2: Line fit plot between earthworm density and soil pH.

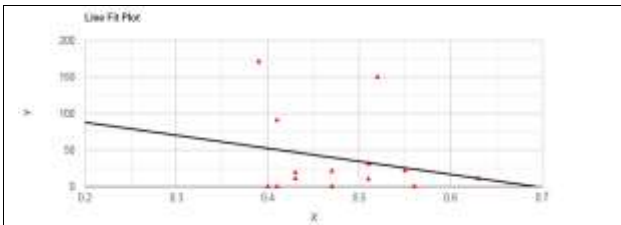


Figure 3: Line fit plot between earthworm density and electrical conductivity.

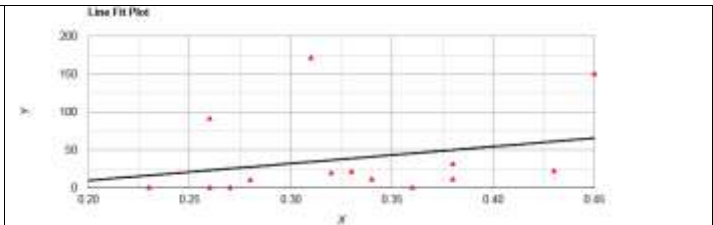


Figure 4: Line fit plot between earthworm density and carbon content.

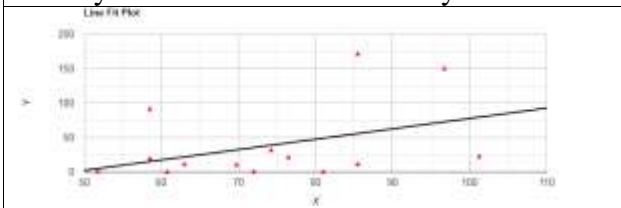


Figure 5: Line fit plot between earthworm density and nitrogen content.

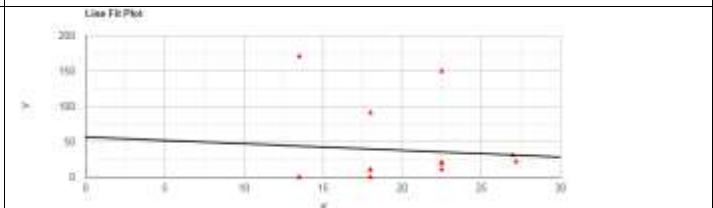


Figure 6: Line fit plot between earthworm density and phosphorus content.

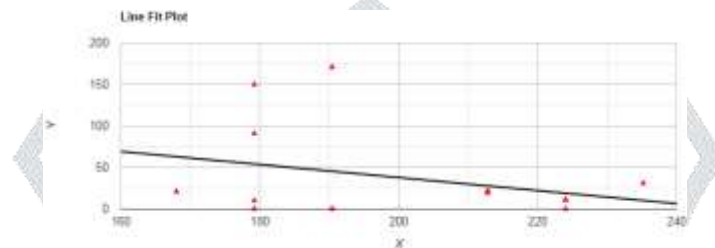


Figure 7: Line fit plot between earthworm density and potassium content.

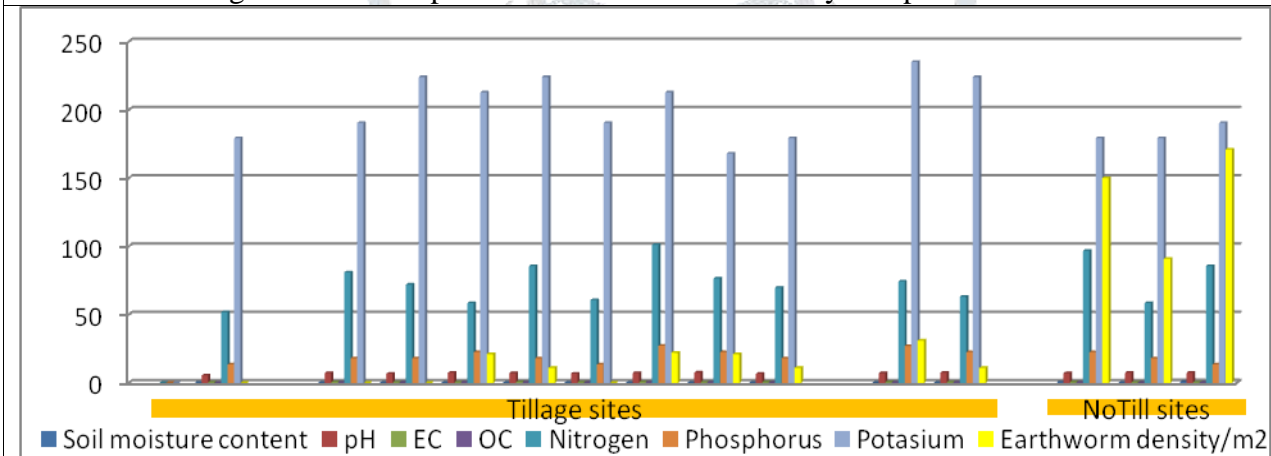


Figure 8: Physical and chemical parameters of soil at Tillage and No-till sites.



Figure 9: Working site, earthworm castings and collected sample.

**Table 1:** Physical parameters (Soil texture, moisture, pH, EC, OC, Nitrogen, Phosphorus, Potassium) of soil, earthworm density, land use, Tillage & No till record, site location and owners detail of selected sites.

S. No	Khashra No.	Name of land owner	Location	Land use type	Tillage/ No till	Soil texture	Soil moisture content	pH	Electrical Conductivity	Organic Carbon Content	Nitrogen Kg/hectare	Phosphorus Kg/hectare	Potassium Kg/hectare	Latitude	Longitude	Earthworm density/m <sup>2</sup>
1	75	Ram Krishna	Jot Awasthi	Agriculture	<b>Tillage</b>	Loam	15 %	5.6	0.40	0.23	51.75	13.5	179.2	82.687917	26.531623	00
2	60	Thakura Devi	Jot Awasthi	Agriculture	<b>Tillage</b>	Loam	16 %	7.3	0.56	0.36	81.00	18.0	190.4	82.693430	26.538325	00
3	76	Ram Achal	Jot Awasthi	Agriculture	<b>Tillage</b>	Loam	17 %	6.7	0.41	0.26	72.00	18.0	224.0	82.687347	26.529247	00
4	58	Chottelal	Jot Awasthi	Agriculture	<b>Tillage</b>	Sandy loam	17 %	7.4	0.43	0.32	58.50	22.5	212.8	82.708958	26.540146	21
5	26	Krishna Mohan	Jot Awasthi	Agriculture	<b>Tillage</b>	Sandy loam	8 %	7.1	0.63	0.34	85.50	18.0	224.0	82.687347	26.529247	11
6	05	Shatrughan Verma	Jot Awasthi	Agriculture	<b>Tillage</b>	Loam	17 %	6.8	0.47	0.27	60.75	13.5	190.4	82.682518	26.534961	00
7	686	Vishwanath	Rampur Kalan	Agriculture	<b>Tillage</b>	Loam	17 %	7.3	0.55	0.43	101.25	27.2	212.8	82.692323	26.523224	22
8	480	Abhay Verma	Rampur Kalan	Agriculture	<b>Tillage</b>	Loam	14 %	7.6	0.47	0.33	76.50	22.5	168.0	82.701474	26.531391	21
9	652	Karamchand	Rampur Kalan	Agriculture	<b>Tillage</b>	Sandy loam	14 %	6.7	0.51	0.28	69.75	18.0	179.2	82.686572	26.523485	11
10	686	Harinath	Rampur Kalan	Agriculture	<b>Tillage</b>	Sandy	3 %	7.1	0.51	0.38	74.25	27.0	235.2	82.692323	26.523224	31
11	284	Santram	Rasoolpur Mubarakpur	Agriculture	<b>Tillage</b>	Black loam	15 %	7.5	0.43	0.38	63.00	22.5	224.0	82.696625	26.538932	11
12	92	Radheshyam	Jot Awasthi	Orchid	<b>No till</b>	Sandy loam	39 %	7.1	0.52	0.45	96.75	22.5	179.2	82.708958	26.540146	150
13	475	Roadside	Rampur Kalan	Road side	<b>No till</b>	Sandy	9 %	7.5	0.41	0.26	58.50	18.0	179.2	82.687452	26.526618	91
14	574	Pond edge	Rampur Kalan	Pond edge	<b>No till</b>	Black loam	76 %	7.4	0.39	0.31	85.50	13.5	190.4	82.692323	26.523224	171

Average annual rainfall – 899.85mm

Average annual temperature -25°C to 28°C

\*Physical parameters of soil were recorded at Soil testing laboratory, Ambedkar Nagar.

**REFERENCES:**

1. A.D. Mackay, J.A. Springett \*, J.K. Syers, P.E.H. Gregg. 1983. Origin of the effect of earthworms on the availability of phosphorus in a phosphate rock. *Soil Biology and Biochemistry*, Volume 15 (1): 63-73.
2. Christoph Emmerling <sup>a</sup>, Thorsten Ruf <sup>a</sup>, Varentta Audu <sup>a</sup>, Willy Werner <sup>b</sup>, Thomas Udeloven. 2021. Earthworm communities are supported by perennial bioenergy cropping systems. *European Journal of Soil Biology*, Volume 105: 103-331.
3. E. Lapied <sup>a</sup>, J. Nahmani <sup>b</sup>, G.X. Rousseau. 2009. Influence of texture and amendments on soil properties and earthworm communities. *Applied Soil Ecology*, 43: 241–249.
4. E. Blanchart, P. Lavelle, E. Braudeau, Y. Le Bissonnais, C. Valentin. 1997. Regulation of soil structure by geophagous earthworm activities in humid savannas of Côte d'Ivoire. *Soil Biology and Biochemistry* Volume 29 (3–4): 431-439.
5. Edwards and lofty. 1982. Earthworm ecology in cultivated soils. *Earthworm ecology*, 123-137.
6. Garfield J. House, Robert W. Parmelee. 1985. Comparison of soil arthropods and earthworms from conventional and no-tillage agroecosystems. *Soil and Tillage Research*. Volume 5(4): 351-360.
7. George G. Brown, Norton P. Benito, Amarildo Pasini, Klaus D. Sautter, Maria de F Guimarães, Eleno Torres. 2003. No-tillage greatly increases earthworm populations in Paraná state, Brazil: The 7th international symposium on earthworm ecology. *Pedobiologia* Volume 47(Issues 5–6): 764-771.
8. Gunn, A. 1992. The use of mustard to estimate earthworm populations. *Pedobiologia*, 36: 65–67.
9. Humberto Blanco-Canqui, Sabrina J. Ruis. 2018. No tillage and soil physical environment. Volume 326: 164-200.
10. J.G. Zaller, J.A. Arnone III. 1999. Earthworm and soil moisture effects on the productivity and structure of grassland communities. *Soil Biology and Biochemistry*, 31: 517-523.
11. J.L. Johnson-Maynard, K.J. Umiker, S.O. Guy. 2007 Earthworm dynamics and soil physical properties in the first three years of no-till management. *Soil and Tillage Research* Volume 94(2): 338-345.
12. J.P. Curry, D. Byrne. 1992. The role of earthworms in straw decomposition and nitrogen turnover in arable land in Ireland. *Soil Biology and Biochemistry*. Volume 24,(12): 1409-1412.
13. John C. Buckerfield. 1992. Earthworm populations in dryland cropping soils under conservation-tillage in south Australia. *Soil Biology and Biochemistry*. Volume 24 (12): 1667-1672.
14. John C. Buckerfield, Diana M. Wiseman. 1997. Earthworm populations recover after potato cropping. *Soil Biology and Biochemistry*. Volume 29(3–4): 609-612.
15. K. I. Peverill, I. A. Sparrow, D. J. Reuter. 1999. Soil analysis: an interpretation manual.
16. K.P. Barley. 1961. The Abundance of Earthworms in Agricultural Land and Their Possible Significance in Agriculture, *Advances in Agronomy*, Volume 13: 249-268.
17. K.Y Chan. 2001. An overview of some tillage impacts on earthworm population abundance and diversity — implications for functioning in soils. *Soil and Tillage Research*. Volume 57(4): 179-191.
18. Kwong-Yin Chan <sup>a</sup>, Katrina Munro. 2001. Evaluating mustard extracts for earthworm sampling. *Pedobiologia*. Volume 45(3): 272-278.
19. Lee. 1985. Earthworms: their ecology and relationships with soils and land use. 411 pp.
20. M. Jill Clapperton, James J. Miller, Francis J. Larney, C. Wayne Lindwall. 1997. Earthworm populations as affected by long-term tillage practices in southern Alberta, Canada. *Soil Biology and Biochemistry*. Volume 29(3–4), 631-633.
21. Manuel Aira, Fernando Monroy, Jorge Domínguez \*, Salustiano Mato. 2002. How earthworm density affects microbial biomass and activity in pig manure. *European Journal of Soil Biology*. 38: 7–10.
22. Patrick j. Bohlen, Robert w. Parmelee, David a. McCartney and Clive a. Edwards. 1997. Earthworm effects on carbon and nitrogen dynamics of Surface litter in corn agroecosystems. *Ecological Applications*, 7(4): 1341–1349.
23. Paul F. Hendrix, Clive A. Edwards. 2004 Earthworms in Agroecosystems: Research Approaches. *Earthworm ecology*. Edition 2: page-09.

24. Pratik Acharya and C.S.K. Mishra. 2020. Earthworm population density and diversity with Respect to soil physico chemical properties, microbial population and exoenzyme dynamics in two agroclimatic Zones of Odisha. India. *Eco. Env. & Cons.* 26 (August Suppl. Issue): 216-225.
25. R. W. Parmelee, M. H. Beare, W. Cheng, P. F. Hendrix, S. J. Rider, D. A. Crossley Jr. & D. C. Coleman. 1990. Earthworms and enchytraeids in conventional and no-tillage agroecosystem: A biocide approach to assess their role in organic matter breakdown. *Biology and fertility of soil.* volume 10: 1-10.
26. RAS Waters. 1955. Numbers and weights of earthworms under a highly productive pasture.
27. S. M. J. Stockdill et.al. 1966. The effect of earthworms on pastures, proceedings (new zealand ecological society).13: 68-75.
28. Subin Kalu<sup>1</sup>, Madan Koirala<sup>1</sup> and Udhav Raj Khadaka. 2015. Earthworm population in relation to different land use and soil characteristics. *Journal of ecology and the natural environment.* 7(5): 124-131.
29. Watkin B R and Wheeler J L. 1966. Some factors affecting earthworm populations under pasture. *Grass and Forage Science.* volume 21(1): 14-20.

