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Influence of Physico-chemical properties of Soil on the Abundance of White Grub in Garden Land Ecosystem

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ABSTRACT: The subterranean nature of white grubs brings a serious issue to crop production and causing heavy economic losses to commercial crops. A study has been conducted to understand the influence of soil physico-chemical properties on the abundance of white grubs in garden land ecosystem. Exploratory surveys were conducted in two districts of Tamil Nadu *viz*., Erode (Sathyamangalam block) and Thoothukudi (Kayathar block). Adult white grubs were collected by soil excavation from the fields of bhendi, maize, sorghum, blackgram, sugarcane, jasmine and tuberose. Soil samples were also collected from the above locations. Morphological examination revealed the occurrence of *Holotrichia serrata* and *Adoretus* sp. Adult abundance and soil physico-chemical properties were correlated. Bulk density, electrical conductivity and soil organic carbon had positive relation with *Holotrichia serrata* abundance whereas particle density, porosity and pH exhibited negative relation. In case of *Adoretus* sp, negative correlation was observed between bulk density, porosity and electrical conductivity and its abundance. The parameters *viz*., particle density, pH and soil organic carbon had positive relation with *Adoretus* abundance. *H. serrata* and *Adoretus* sp prefers hard and loose texture soils, respectively.

Keywords: White grubs, garden land, *Holotrichia serrata*, *Adoretus* sp, abundance, soil properties, correlation.

INTRODUCTION

White grubs are the pest of national importance in India (Mehta *et al*., 2010). They belong to the two subfamilies *viz*., Melolonthinae and Rutelinae of the family Scarabaeidae under the order Coleoptera. In India, occurrence of more than 1700 species of white grubs have been reported (Ali, 2001). Due to the subterranean nature, white grubs cause remarkable damage to the roots of several agricultural and horticultural crops. The damage and can be visualized by drying, wilting and withering of plants in patches (Rai *et al*., 1969). Many times, the infestation is misunderstood with physiological wilting and detected only after complete destruction of crops. The grubs are “C” shaped, fleshy with three pairs of thoracic legs (Sreedevi *et al*., 2014). The first instar grub feeds on soil debris rich in organic matter whereas later instars are phytophagous and feed voraciously on roots. Grubs exploits the roots of sugarcane, groundnut, potato, maize, pearl millet, wheat, sorghum and barley; whereas adults feed on leaves of bhendi, neem, acacia, grapes etc., (Fujiie *et al*., 1996; Ranga Rao *et al*., 2006). Active adult emergence of most species coincides with monsoon showers (Yadava and Sharma 1995). The impact of soil properties on the abundance of white grub population is lacking in Tamil Nadu, so a study on the effect of physicochemical properties on distribution and abundance was undertaken in the districts of Erode and Thoothukudi in Tamil Nadu.

MATERIALS AND METHODS

Study site. An exploratory survey was conducted from December 2021 to April 2022 in two districts of Tamil

Nadu to collect white grub adults associated with garden land crops. The details of the sampling area are given in Table 1.

Adult sampling. Each location sampled once in a square meter area delineated in five places on a one-acre crop area. Adult white grubs were collected by excavation of soil (50 - 60 cm deep) in the crop ecosystem and also from the emergence sites. In Kayathar block, adult collections were made from the bhendi, maize, sorghum and black gram fields and in Sathyamangalam block, adults were collected from sugarcane, jasmine and tuberose fields.

Identification of adults. Adult white grub identification was done by following keys of Arrow (1917) and Dadmal (2013).

Soil physico-chemical analysis. In both locations, soil samples were collected by following the methodology of Cherry and Allsopp (1991). Samples collected from 50 × 50 cm area up to a depth of 40 cm. A representative sample of 500g soil was collected from each sampling site.

Soil physical parameters such as texture, bulk density, particle density, porosity and chemical properties such as pH, electrical conductivity and soil organic carbon, surface soil organic matter and sub surface soil organic matter were analyzed at Soil Science Laboratory, Department of Remote sensing and GIS, TNAU, Coimbatore. The details of the methods used for analysis are presented in Table 2.

Table 1: Geo coordinates of sampling locations of two districts.

S. No.	Location	Latitude	Longitude	District/ Block	Average annual rainfall (mm) (Source: NASA POWER)
1.	UPM 1	11.5068 ° N	77.1885 ° E	Erode (Sathyamangalam block)	166.29
2.	UPM 2	11.5075 ° N	77.1872 ° E		
3.	UPM 3	11.5066 ° N	77.1892 ° E		
4.	MP	11.5102 ° N	77.2855 ° E		
5.	TKM 1	9.0157 ° N	77.7799° E	Thoothukudi (Kayathar block)	102.86
6.	TKM 2	9.0132° N	77.7181° E		
7.	TKM 3	9.0160° N	77.7187 ° E		
8.	TKM 4	9.0159° N	77.7170° E		
TKM- Tirumangalakurichi; UPM – Uppupallam; MP- Malayadipudhur.					

Table 2: Particulars of soil physico-chemical parameters and methodology followed.

Soil physico- chemical parameters	Methodology	References
Bulk density, particle density andporosity	Cylindrical method	Gupta (1981)
Texture	Feel method	Arshad and Coen (1992)
pH	1:2.5 Soil water suspension by pH meter	Jackson (1973)
Electrical Conductivity (EC)	1:2.5 Soil water suspension by EC meter	
Soil organic carbon, surface soil organic matter and sub surface soil organic matter	Chromic acid wet digestion method	Walkley and Black (1934)

Statistical analysis. Mean adult population transformed by square root transformation ($\sqrt[2]{X+0.5}$) (Gomez and Gomez, 1984). To understand the influence of soil physico-chemical parameters on adult white grub abundance, correlation and regression studies were performed.

RESULTS AND DISCUSSION

Morphological characterization of white grub adults, collected in the study, revealed the occurrence of *Holotrichia serrata* (Fabricius) (Melolonthinae; Scarabaeidae; Coleoptera) and *Adoretus* sp (Rutelinae; Scarabaeidae; Coleoptera) in Erode and Thoothukudi districts, respectively.

Abundance of white grub species and physico-chemical properties of soil collected from Erode and Thoothukudi districts are presented in Table 3 and 5, respectively. Results of correlation performed between adult white grub population and soil physico-chemical properties are given in Table 4 and 6, respectively. Figures 1–12 depict a regression study between the mean adult population of *Holotrichia serrata* and *Adoretus* sp with each physicochemical parameter.

Bulk density of soil exhibited positive and negative relation with *H. serrata* (r = -0.268) and *Adoretus* sp (r = 0.368) abundance, respectively. The results are in accordance with the findings of Pujari *et al*. (2018) and Pal (1997). Pujari (2018) concluded that bulk density had a negative (significant) relationship with the average population of *Lepidiota mansueta* Burmeister larvae, whereas clay and silt content had a positive (non-significant) relationship with larval population as well as the report validating the textural preferences of *Holotrichia serrata*. Pal (1997) documented that population of white grubs influenced by coarse texture and low precipitation of rainfall, and the study corroborating those textural preferences of adults of *Adoretus* sp. Particle density of soil non significantly affecting the both the population but, positive relationship with *Adoretus* sp (Table 6) and negative relationship with *Holotrichia serrata* (Table 4).

Soil porosity had a significant negative correlation (r = - 0.995) with abundance of *Adoretus* sp and non-significant negative correlation (r = -0.643) with *H. serrata* abundance. Both species preferred loam, sandy loam and silt loam soils. Earlier findings indicated that white grubs' oviposition (Potter, 1983; Allsopp, 1992) and migration of larvae depend on the proportion of soil particles (Gustin and Schumacher, 1989). Chemical parameters such as pH and Electrical Conductivity (EC) had negative and positive correlation (non-significant) with *H. serrata* abundance whereas vice-versa was observed for *Adoretus* sp.

Soil organic content was found to be positively linked with the abundance of both species of white grubs, acting as a facilitating factor. Present findings are analogous with Cherry and Coale (1994), they reported that *Tomarus subtropicus* Blatchley positively correlated with organic matter of the soil. Afore mentioned parameter also determines the feeding nature of *Dasylepida ishigakiensis* (Niijima and Kinoshita) (Oyafuso *et al*., 2002) and tunneling depth of *Phyllophaga ephilida* Say (Diagne 2004).

Table 3: Abundance of *Holotrichia serrata* adults with physicochemical properties of soil collected from Erode district.

Crop	Location	Physical Parameters				Chemical parameters					Adults/ Sq.m**
		Texture	BD (Mg/m^3)	PD (Mg/m^3)	Porosity (%)	pH	EC (dS/m)	SOC (%)	Surface SOM (%)	Sub surface SOM (%)	
Tuberose	UPM 1	Loam	1.111	1.25	11.111	7.26	0.46	0.345	0.595	0.863	0.948
Jasmine	UPM 2	Sandy loam	1.025	1.333	23.076	6.87	1.47	0.690	1.190	1.726	1.048
Sugarcane	UPM 3	Sandy loam	1.052	1.176	10.526	6.77	1.67	0.992	1.711	2.482	1.224
	MP	Loam	1.052	1.481	28.947	7.66	0.49	0.776	1.339	1.942	0.836

UPM- Uppupallam; MP- Malayadipudhur; LAT = Latitude, LONG = Longitude, BD = Bulk density, PD = Particle density, SOC = Soil Organic Carbon, SOM = Soil Organic Matter; Adults/ Sq.m** – Transformed value.

Table 4: Correlation of abundance of *Holotrichia serrata* with physico-chemical parameters of soil gathered from Erode district.

	BD (Mg/m3)	PD (Mg/m3)	Porosity (%)	pH	EC (dS/m)	SOC (%)	Surface SOM (%)	Sub surface SOM (%)	Adults/ Sq.m**
BD (Mg/m^3)	1								
PD (Mg/m^3)	-0.293	1							
Porosity (%)	-0.561	0.953	1						
pH	0.325	0.784	0.564	1					
EC (dS/m)	-0.652	-0.533	-0.259	-0.907	1				
SOC (%)	-0.704	-0.045	0.142	-0.330	0.6677	1			
Surface SOM (%)	-0.704	-0.045	0.142	-0.330	0.667	1	1		
Sub surface SOM (%)	-0.704	-0.045	0.1425	-0.330	0.667	1	1	1	
Adults/ Sq.m**	-0.268	-0.832	-0.643	-0.934	0.899	0.533	0.532	0.532	1

LAT = Latitude, LONG = Longitude, BD = Bulk density, PD = Particle density, SOC = Soil Organic Carbon, SOM = Soil Organic Matter; Adults/ Sq.m** – Transformed value; Correlation is significant at the 0.05 level (2 tailed) *

Table 5: Abundance of adults of *Adoretus* sp with physico-chemical properties of soil collected from Thoothukudi district.

Crop	Location	Physical Parameters				Chemical parameters					Adults/ Sq.m**
		Texture	BD (Mg/m3)	PD (Mg/m3)	Porosity (%)	pH	EC (dS/m)	SOC (%)	Surface SOM (%)	Sub surface SOM (%)	
Bhendi	TKM 1	Sandy loam	1.052	1.250	15.789	7.12	0.25	0.863	1.488	2.158	18.6
Sorghum	TKM 2	Loamy sand	1.025	1.250	17.948	6.86	0.37	0.820	1.413	2.050	9.4
Maize	TKM 3	Sandy loam	1.111	1.333	16.666	6.87	0.28	0.733	1.265	1.834	13.8
Black gram	TKM 4	Silt loam	0.869	1.052	17.391	7.58	0.36	0.388	0.669	0.971	11.6

TKM- Tirumangalakurichi; LAT = Latitude, LONG = Longitude, BD = Bulk density, PD = Particle density, SOC = Soil Organic Carbon, SOM = Soil Organic Matter; Adults/ Sq.m** – Transformed value.

Table 6: Correlation of abundance of *Adoretus* sp with physico-chemical parameters of soil collected from Thoothukudi district.

	BD (Mg/m3)	PD (Mg/m3)	Porosity (%)	pH	EC (dS/m)	SOC (%)	Surface SOM (%)	Sub surface SOM (%)	Adults/ Sq.m **
BD (Mg/m^3)	1								
PD (Mg/m^3)	0.994	1							
Porosity (%)	-0.430	-0.331	1						
pH	-0.898	-0.937	0.014	1					
EC (dS/m)	-0.642	-0.557	0.965	0.253	1				
SOC (%)	0.839	0.836	-0.358	-0.839	-0.502	1			
Surface SOM (%)	0.839	0.836	-0.358	-0.839	-0.502	1	1		
Sub surface SOM (%)	0.839	0.836	-0.358	-0.839	-0.502	1	1	1	
Adults/ Sq.m**	0.368	0.267	-0.995*	0.040	-0.940	0.341	0.341	0.341	1

LAT = Latitude, LONG = Longitude, BD = Bulk density, PD = Particle density, SOC = Soil Organic Carbon, SOM = Soil Organic Matter, Adults/ Sq.m** – Transformed value; Correlation is significant at the 0.05 level (2 tailed) *

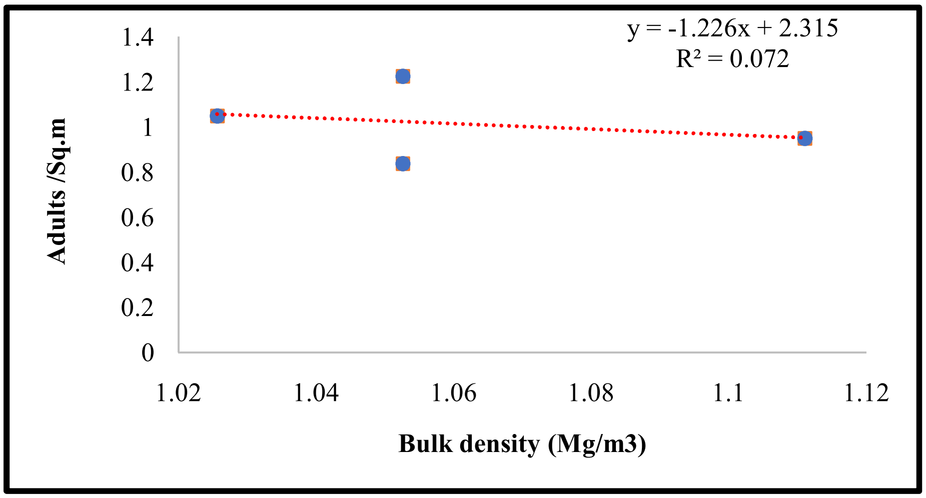

Fig. 1. Relationship between adult populations of *Holotrichia serrata* and Bulk density of the soil.

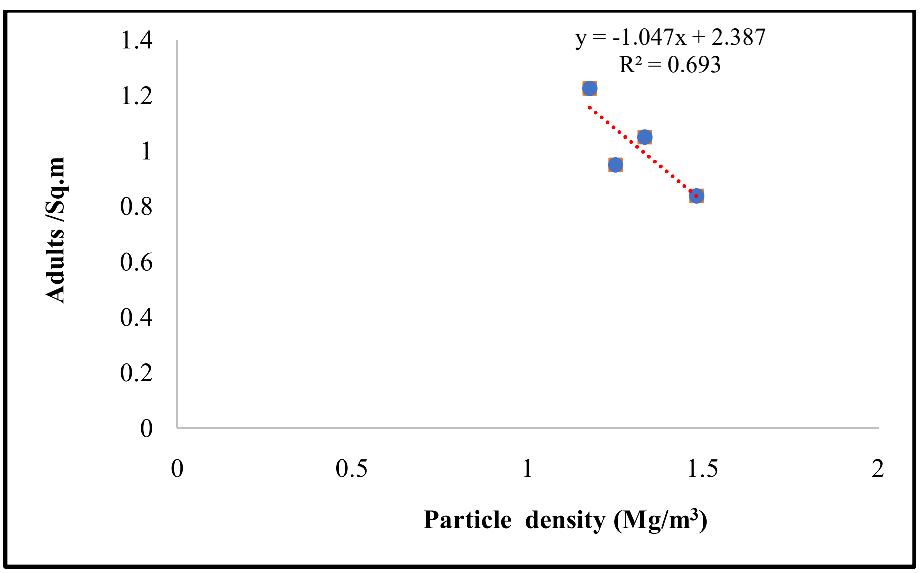

Fig. 2. Relationship between adult populations of *Holotrichia serrata* and Particle density of the soil.

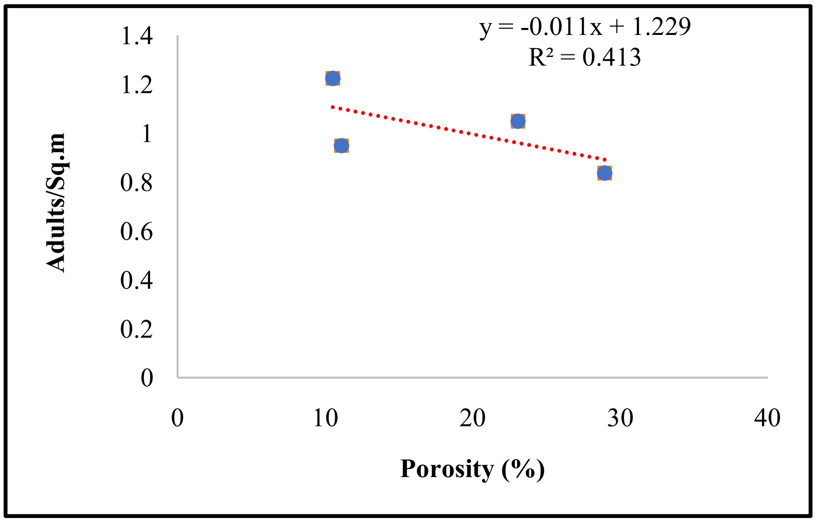

Fig. 3. Relationship between adult populations of *Holotrichia serrata* and Porosity of the soil.

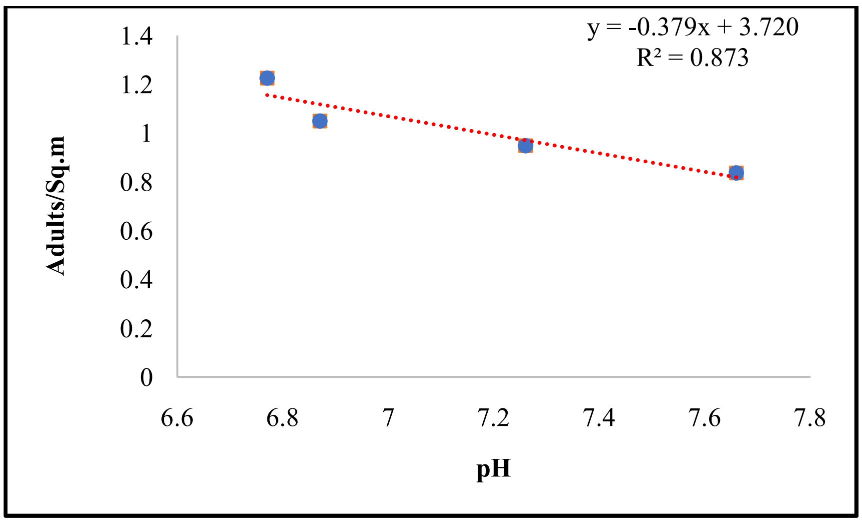

Fig. 4. Relationship between adult populations of *Holotrichia serrata* and pH of the soil.

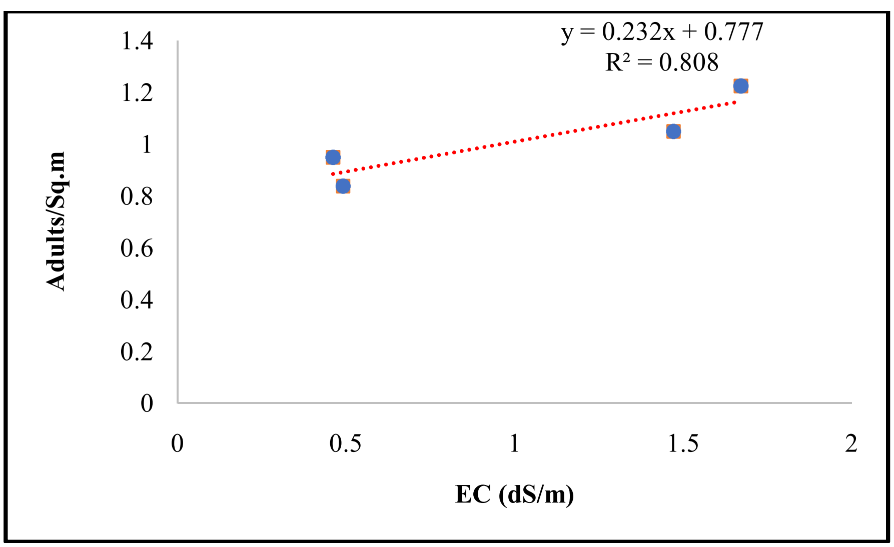

Fig. 5. Relationship between adult populations of *Holotrichia serrata* and EC of the soil.

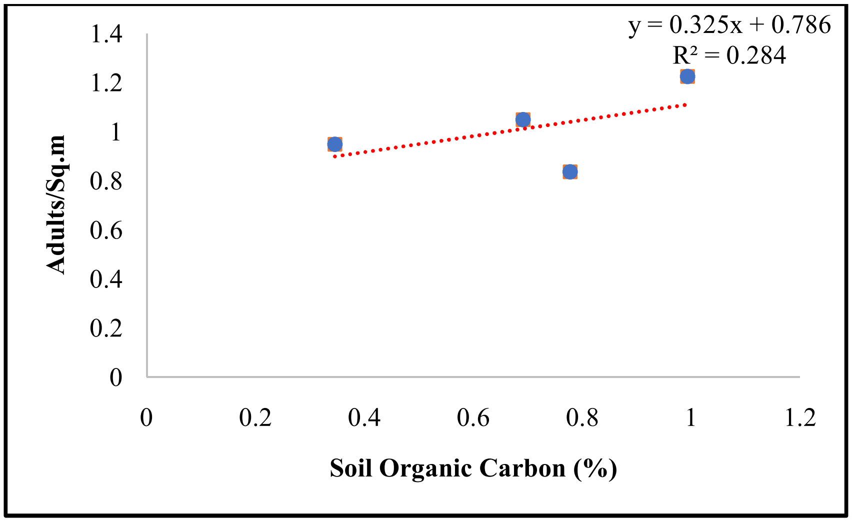

Fig. 6. Relationship between adult populations of *Holotrichia serrata* and Soil organic carbon of the soil.

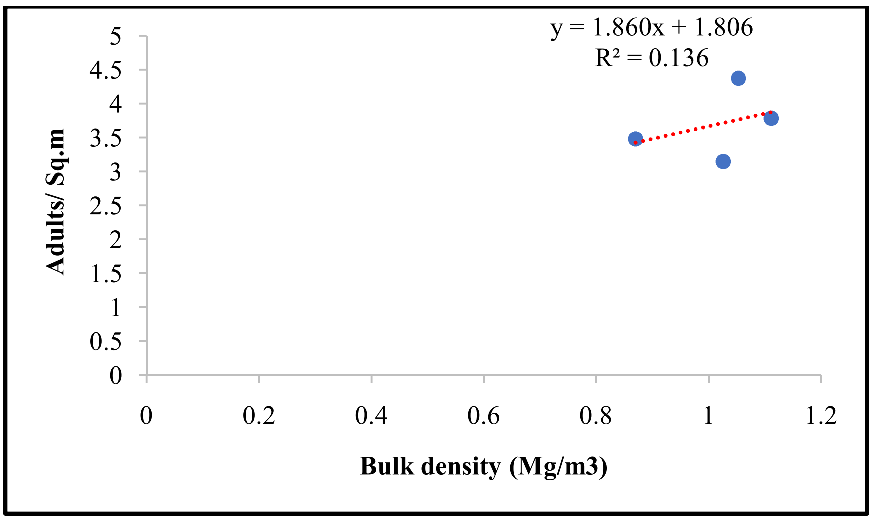

Fig. 7. Relationship between the adult populations of *Adoretus* sp and bulk density of the soil.

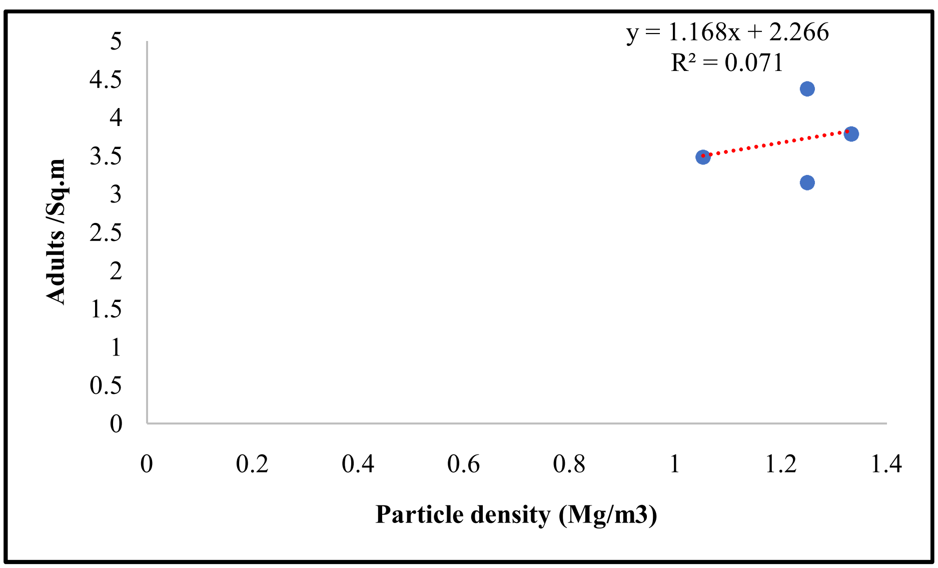

Fig. 8. Relationship between the adult populations of *Adoretus* sp and particle density of the soil.

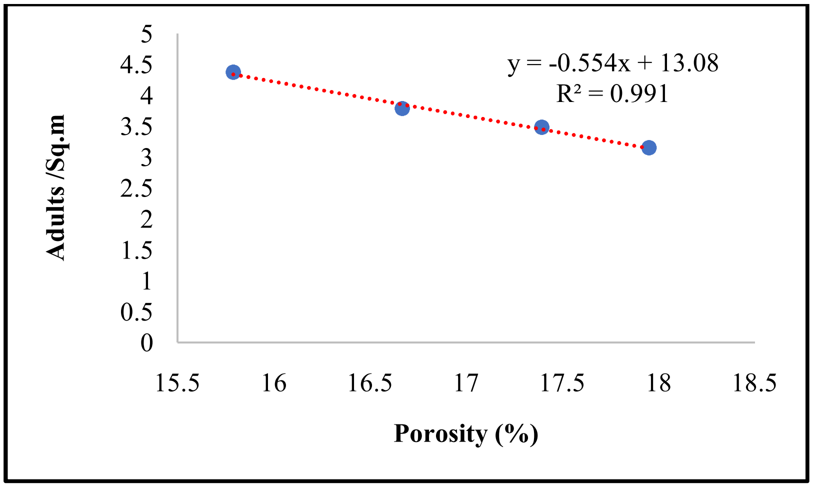

Fig. 9. Relationship between the adult populations of *Adoretus* sp and porosity of the soil.

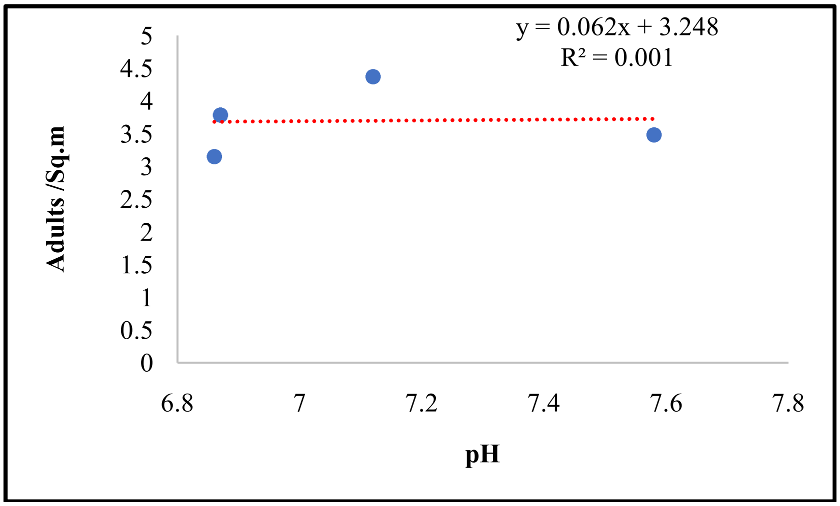

Fig. 10. Relationship between the adult populations of *Adoretus* sp and pH of the soil.

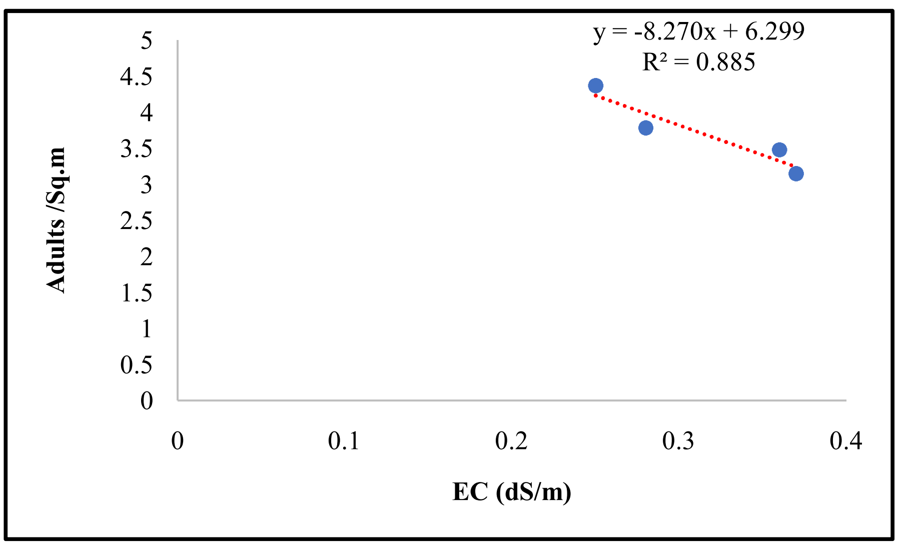

Fig. 11. Relationship between the adult populations of *Adoretus* sp and EC of the soil.

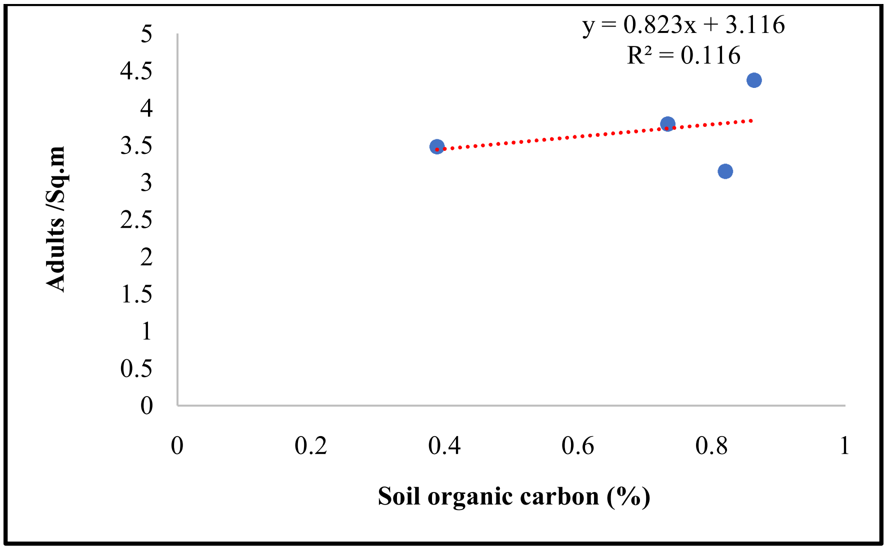

Fig. 12. Relationship between the adult populations of *Adoretus* sp and Soil organic of the soil.

CONCLUSION

The study revealed the occurrence and abundance of *H. serrata* and *Adoretus* sp in garden land crops of Erode (Sathyamangalam block) and Thoothukudi (Kayathar block) districts. With respect to soil physico-chemical parameters, bulk density and soil porosity had a positive and negative association with *H. serrata* abundance, respectively. In case of *Adoretus* sp, both parameters exhibited negative relationship. Hence it can be concluded that, *H. serrata* prefers loamy to hard texture and can penetrate to a moderately deep of the soil to feed the roots of crops whereas *Adoretus* sp prefers shallow depth and moderately loamy to light textured soil. However, both species require organic matter for survival and abundance. Furthermore, soil moisture and precipitation play a role in the emergence and dispersal of the white grub population.

FUTURE SCOPE

This study is contributing the base line for the assessment and distribution of phytophagous scarab fauna in soil habitat. It will bring the solution to manage the pest by altering the agronomic practices and in another way, it may act as tool to measure the biodiversity richness of soil scarabs with regard to the changes in edaphic and environmental factors.

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Conflict of interest. Nil.

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