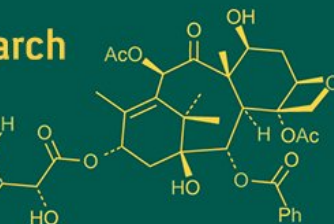
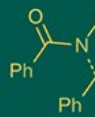


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Study on distribution patterns of white grub species in relation to abiotic factors in western Maharashtra

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Abstract

The present investigation was conducted during 2025-26 to study the distribution pattern of white grub species in relation to prevailing climatic conditions in Western Maharashtra. Field surveys were carried out in five districts namely Kolhapur, Sangli, Satara, Pune and Solapur representing contrasting agro-climatic conditions. Adult scarabaeid beetles were collected from selected localities following rainfall using light traps, pheromone lures and hand collection from commonly occurring host trees. The collected beetles were identified up to species level and their abundance was analysed district-wise. A total of 4,342 adult beetles representing nineteen species under five subfamilies were recorded. Melolonthinae was the most represented subfamily. Kolhapur recorded the highest collection (2,001 beetles and 19 species), followed by Sangli (798 and 14 species), Pune (539 and 4 species), Satara (531 and 12 species) and Solapur (473 and 4 species). *Holotrichia serrata* was the most abundant species overall, with 1,104 individuals, and was dominant in Kolhapur, Satara, Pune and Solapur, whereas *Phyllognathus dionysius* was dominant in Sangli. Adult emergence generally increased after rainfall and attained peak abundance during the active monsoon period. Correlation analysis showed positive associations of beetle emergence with rainfall and relative humidity, whereas maximum temperature, minimum temperature and evaporation showed negative associations. The findings indicated considerable variation in species composition and abundance among districts and demonstrated the importance of rainfall, temperature and atmospheric humidity in determining the occurrence and seasonal activity of white grub beetles in Western Maharashtra.

Keywords: White grub, Scarabaeidae, species distribution, abundance, rainfall, relative humidity, temperature, western Maharashtra.

Introduction

White grubs are economically important soil-inhabiting scarabaeid beetles whose adults emerge seasonally, generally following the onset of rainfall. Their occurrence is closely associated with agro-ecological conditions, host plants and the availability of suitable soil moisture. Because several scarabaeid species occur together within agricultural landscapes, knowledge of their distribution and abundance is important for understanding the composition of the white grub complex and for planning location-specific monitoring and management.

The white grub fauna of Maharashtra is diverse and includes several economically important species associated with agricultural ecosystems. Bhawane *et al.* (2012) [3], documented substantial diversity of white grub beetles and their host range in the Northern Western Ghats, while Gite *et al.* (2015) [7], reported the distribution of white grub species in Western Maharashtra. Anitha *et al.* (2006) [2], also documented the distribution and abundance of white grubs associated with groundnut in southern India, indicating that species composition can vary across locations and agro-climatic situations.

The seasonal activity of adult scarabaeid beetles is strongly influenced by weather. Rainfall can act as an environmental cue for emergence by increasing soil moisture, while relative humidity may favour adult activity and survival. Conversely, higher temperature and evaporation can contribute to moisture loss and may influence the timing and magnitude of adult emergence. Dashad *et al.* (2008) [6], and Kumar *et al.* (2009) [10], reported the importance of rainfall in regulating white grub emergence and seasonal population activity, while Ahad *et al.* (2011) [1], and Khanal *et al.* (2012) [8], highlighted the role of abiotic

conditions in determining scarabaeid abundance and distribution. Western Maharashtra contains contrasting agro-climatic environments ranging from relatively humid regions to semi-arid areas. Such variation provides an appropriate setting for examining differences in white grub species composition, abundance and seasonal emergence. Therefore, the present study was undertaken to document the distribution pattern of white grub species across five districts of Western Maharashtra and to assess their association with prevailing abiotic factors during the study period.

Materials And Methods

Study area and sampling sites

The distribution of white grub beetles was studied in five districts of Western Maharashtra namely Kolhapur, Sangli, Satara, Pune and Solapur. Sampling sites were selected considering the prevailing cropping pattern and the presence of suitable host trees near roadsides and agricultural fields. The surveyed localities represented the principal sampling areas within the selected districts. Adult beetles were collected after receipt of rainfall from host trees and from locations adjoining commercial crops.

Collection of adult beetles

Adult scarab beetles emerged from the soil mainly during the evening and night following rainfall. Accordingly, surveys were conducted approximately between 6:45 pm and 10:00 pm during period of adult emergence. Three collection approaches were followed. White grub pheromone lures were used for attracting scarabaeid beetles. Light traps fitted with ultraviolet or LED bulbs were installed at selected farmer fields and attracted beetles were collected through a funnel and nylon-net arrangement. Hand collection was also undertaken after the first pre-monsoon showers by shaking branches of commonly occurring host trees and collecting beetles manually. Neem (*Azadirachta indica*), wild ber (*Ziziphus sp.*), babhul (*Acacia arabica*) and khair (*Acacia catechu*) were among the host trees surveyed.

Identification and estimation of abundance

Collected adult beetles were pinned and preserved properly and were submitted to the All India Network Project on White Grub and Other Soil Arthropods, Bengaluru, Karnataka, for taxonomic identification. The number of adults belonging to each species was recorded for each sampling locality and subsequently pooled district-wise. Species abundance was expressed as the number and percentage of adults collected.

Species diversity and relationship with abiotic factors

Species diversity and abundance were analysed using Simpson's diversity index as described by Biranvand *et al.* (2014). Weekly observations of adult beetle emergence were related to meteorological parameters recorded during the same period. The abiotic variables considered were rainfall (mm), maximum temperature (°C), minimum temperature (°C), morning relative humidity (%), evening relative humidity (%) and evaporation (mm day⁻¹). Correlation coefficients were calculated to assess the association between weekly adult abundance and the recorded weather parameters. Observations covered meteorological weeks 11th to 35th during 2025-26.

Results And Discussion

Distribution pattern and abundance of white grub species in Western Maharashtra

During the investigation, 4,342 adult beetles representing nineteen species were recorded from the five surveyed districts of Western Maharashtra. The species belonged to five subfamilies, namely Melolonthinae, Rutelinae, Dynastinae, Cetoniinae and Hybosorinae. Melolonthinae constituted the most represented group. Economically important species including *Holotrichia serrata*, *H. farinosa*, *H. fissa*, *Phyllognathus dionysius*, *Anomala bengalensis* and *Sophrops karschi* were recorded. The variation in species composition among districts indicates differences in the suitability of local agro-climatic conditions, host availability and habitat characteristics.

Table 1: District-wise distribution and abundance of white grub species in Western Maharashtra

District	Species recorded	Total adults	Dominant species	Dominant adults	Dominant (%)
Kolhapur	19	2,001	<i>Holotrichia serrata</i>	352	17.59
Sangli	14	798	<i>Phyllognathus dionysius</i>	223	27.94
Satara	12	531	<i>Holotrichia serrata</i>	170	32.01
Pune	4	539	<i>Holotrichia serrata</i>	233	43.23
Solapur	4	473	<i>Holotrichia serrata</i>	204	43.13
Total	19*	4,342	<i>Holotrichia serrata</i>	1,104	25.43

Note: Nineteen species were recorded in the study area overall; some species occurred in more than one district

Kolhapur district

Kolhapur recorded the highest species richness and adult abundance, with all nineteen recorded species and 2,001 adults. *Holotrichia serrata* was the most abundant species with 352 adults (17.59%), followed by *Anomala bengalensis* (271; 13.54%) and *Phyllognathus dionysius* (258; 12.89%). Other important species included *H. fissa* (162), *Alissonotum piceum* (158) and *H. farinosa* (154). The presence of all nineteen species indicates that Kolhapur supported a comparatively rich scarabaeid assemblage during the survey. Adult emergence in Kolhapur was observed from the 13th meteorological week and reached a maximum of 221 adults during the 28th week. The average rainfall was 55.54 mm, while maximum and minimum

temperatures averaged 31.66 and 20.57°C, respectively. Morning and evening relative humidity averaged 82.32 and 70.08 per cent. Emergence showed positive correlations with rainfall ($r = 0.19^*$), morning relative humidity ($r = 0.04^*$) and evening relative humidity ($r = 0.10^*$), whereas maximum temperature ($r = -0.23$), minimum temperature ($r = -0.97$) and evaporation ($r = -0.33$) were negatively associated. These results indicated the favourable role of moisture conditions in adult emergence. The predominance of *H. serrata* in Kolhapur agrees with Anitha *et al.* (2006) [2], who reported *Holotrichia* species as important components of white grub populations, and with Dadmal and Khadakkar (2014) [5], who documented *H. serrata* across agro-climatic regions of Maharashtra. Gite *et al.* (2015) [7], also recorded

H. serrata among the important white grub species of Western Maharashtra.

Sangli district

Fourteen species and 798 adults were recorded from Sangli district. *Phyllognathus dionysius* was the dominant species with 223 adults (27.94%), followed by *H. serrata* (145; 18.17%) and *A. bengalensis* (117; 14.66%). *Anomala sp.* 2 and *Anomala sp.* 1 contributed 10.90 and 8.27 per cent, respectively. Adult emergence commenced during the 17th meteorological week and reached 108 adults during the 21st week.

The average rainfall was 39.99 mm, with average maximum and minimum temperatures of 33.93 and 21.06°C. Morning and evening relative humidity averaged 79.72 and 70.32 per cent. Beetle emergence was positively associated with rainfall ($r = 0.43^*$), morning relative humidity ($r = 0.91^*$) and evening relative humidity ($r = 0.92^*$), while maximum temperature ($r = -0.76$), minimum temperature ($r = -0.98$) and evaporation ($r = -0.37$) showed negative associations. The predominance of *P. dionysius* under these conditions indicated its successful occurrence within the Sangli agro-ecosystem.

Satara district

Satara yielded 531 adults representing twelve species. *Holotrichia serrata* was the most abundant species with 170 adults (32.01%), followed by *H. fissa* (110; 20.71%), *A. bengalensis* (83; 15.63%) and *H. farinosa* (48; 9.03%). Adult emergence began during the 18th meteorological week with 24 adults and reached 92 adults during the 21st week. The dominance of *Holotrichia* species indicated their successful establishment under the prevailing conditions of the surveyed Satara localities. Average rainfall was 53.91 mm, while maximum and minimum temperatures averaged 32.0 and 21.0°C. Morning and evening relative humidity averaged 85.6 and 72.2 per cent, respectively. Correlation analysis showed positive relationships between emergence and rainfall ($r = 0.62^*$), morning relative humidity ($r = 0.17^*$) and evening relative humidity ($r = 0.88^*$). Maximum temperature ($r = -0.81$), minimum temperature ($r = -0.83$) and evaporation ($r = -0.72$) were negatively associated with adult abundance. These results indicated that rainfall and humid atmospheric conditions were favourable for adult emergence, whereas warmer and drier conditions were associated with reduced abundance. The predominance of *H. serrata* and *H. fissa* in Satara is consistent with the occurrence of *Holotrichia* species as major constituents of white grub populations reported by Anitha *et al.* (2006) [2]. The wider occurrence of *H. serrata* in Maharashtra reported by Dadmal and Khadakkar (2014) [5], and its importance in Western Maharashtra reported by Gite *et al.* (2015) [7] also support the present distribution pattern.

Pune district

Pune recorded 539 adults belonging to four species: *H. serrata*, *H. fissa*, *H. farinosa* and *H. rubroflava*. *Holotrichia serrata* was dominant with 233 adults (43.23%), closely followed by *H. fissa* with 224 adults (41.55%). *H. farinosa* and *H. rubroflava* contributed 68 (12.61%) and 14 (2.59%) adults, respectively. Adult emergence commenced in the 18th meteorological week with seven adults and reached 108 adults during the 21st week.

Average rainfall was 38.79 mm, with maximum and minimum temperatures of 32.57 and 23.18°C, respectively. Morning and evening relative humidity averaged 85.0 and 71.8 per cent, while evaporation averaged 5.57 mm day⁻¹. Adult abundance was positively correlated with rainfall ($r = 0.84^*$), morning relative humidity ($r = 0.35^*$) and evening relative humidity ($r = 0.82^*$), whereas maximum temperature ($r = -0.38$), minimum temperature ($r = -0.89$) and evaporation ($r = -0.45$) showed negative relationships. The strong association with rainfall suggested that moisture availability was an important factor in stimulating adult emergence.

The dominance of *H. serrata* and substantial occurrence of *H. fissa* indicate their adaptation to the prevailing conditions of the surveyed Pune localities. The present observations agree with reports of Anitha *et al.* (2006) [2], Shrilakshmi and Patil (2016) [13], and Dadmal and Khadakkar (2014) [5], regarding the importance and distribution of *Holotrichia* species in agricultural ecosystems.

Solapur district

Solapur recorded 473 adults representing four species. *Holotrichia serrata* was dominant with 204 adults (43.13%), followed by *P. dionysius* (140; 29.60%), *H. fissa* (71; 15.01%) and *H. farinosa* (47; 9.94%). Adult emergence commenced during the 15th meteorological week with 12 adults and attained a maximum of 78 adults during the 22nd week. Thus, adult emergence was recorded even under the comparatively dry conditions prevailing in Solapur.

The average rainfall was only 19.20 mm, whereas maximum temperature averaged 38.04°C. Morning and evening relative humidity averaged 81 and 74 per cent, respectively, and evaporation averaged 6.02 mm day⁻¹. Emergence showed positive correlations with rainfall ($r = 0.29^*$), morning relative humidity ($r = 0.49^*$) and evening relative humidity ($r = 0.69^*$), while maximum temperature ($r = -0.79$), minimum temperature ($r = -0.99$) and evaporation ($r = -0.78$) showed negative associations. These observations indicated that even relatively low rainfall events could stimulate adult emergence under semi-arid conditions when adequate soil moisture became available.

Comparative distribution pattern among districts

Marked differences were observed among the five districts in both species richness and adult abundance. Kolhapur recorded the highest number of species and adults, whereas Pune and Solapur recorded only four species each. Sangli was distinct in having *P. dionysius* as the dominant species, while *H. serrata* predominated in the other four districts. The widespread occurrence of *H. serrata*, *H. farinosa* and *H. fissa* across the surveyed region demonstrated their ability to persist under contrasting agro-climatic conditions. The district-wise pattern broadly corresponded with differences in climatic conditions. Kolhapur and Satara recorded comparatively higher rainfall and humidity and also supported relatively high species richness. Pune had lower average rainfall than Kolhapur and Satara but high relative humidity, and *H. serrata* and *H. fissa* accounted for most of the collection. Solapur experienced the lowest average rainfall and highest maximum temperature, yet *H. serrata* remained dominant, indicating a comparatively broad ecological tolerance of this species. The results were consistent with Gite *et al.* (2015) [7], who documented white grub species in Western Maharashtra, and with Dadmal and

Khadakkar (2014) ^[5], who reported the widespread occurrence of *H. serrata* across Maharashtra.

Seasonal emergence in relation to abiotic factors

Across the districts, adult emergence generally increased after the onset of rainfall and reached its highest abundance during the active monsoon period. The timing of peak emergence varied among districts: Kolhapur recorded its maximum during the 28th meteorological week, Sangli and Satara during the 21st week, Pune during the 21st week, and Solapur during the 22nd week. This variation indicated that the onset and distribution of rainfall, together with local temperature and humidity regimes, influenced the timing of adult activity. Rainfall showed a positive relationship with adult abundance in all five districts. The association was particularly strong in Pune ($r = 0.84^*$) and Satara ($r = 0.62^*$), while positive relationships were also observed in Sangli ($r = 0.43^*$), Solapur ($r = 0.29^*$) and Kolhapur ($r = 0.19^*$). This pattern supported the view that rainfall-induced changes in soil moisture provide an important environmental stimulus for adult emergence. Dashad *et al.* (2008) ^[6], reported increased emergence of white grub beetles following rainfall, while Kumar *et al.* (2009) ^[10], identified rainfall as an important factor governing the

seasonal activity of white grubs. Morning and evening relative humidity showed positive relationships with adult emergence across all districts. Evening relative humidity showed particularly strong associations in Sangli ($r = 0.92^*$), Satara ($r = 0.88^*$), Pune ($r = 0.82^*$) and Solapur ($r = 0.69^*$). Such relationships indicated the favourable influence of moist atmospheric conditions on adult activity and survival. Similar importance of climatic variables in determining white grub abundance and distribution had been reported by Ahad *et al.* (2011) ^[1], Khanal *et al.* (2012) ^[8], and Oliveira and Frizzas (2017) ^[11].

In contrast, maximum temperature, minimum temperature and evaporation showed negative relationships with adult abundance in every district. Minimum temperature showed the strongest negative association in Kolhapur ($r = -0.97$), Sangli ($r = -0.98$), Satara ($r = -0.83$), Pune ($r = -0.89$) and Solapur ($r = -0.99$). Evaporation also showed negative relationships, ranging from -0.33 in Kolhapur to -0.78 in Solapur. Increased temperature and evaporation may reduce soil moisture and thereby create less favourable conditions for adult emergence. The consistent direction of these relationships across districts highlighted the combined influence of moisture availability and atmospheric conditions on seasonal white grub activity.

Table 2: Average abiotic conditions during the white grub emergence period

District	Rainfall (mm)	Max. temp. (°C)	Min. temp (°C)	Morning RH (%)	Evening RH (%)	Evaporation (mm day ⁻¹)
Kolhapur	55.54	31.66	20.57	82.32	70.08	4.90
Sangli	39.99	33.93	21.06	79.72	70.32	4.97
Satara	53.91	32.00	21.00	85.60	72.20	5.20
Pune	38.79	32.57	23.18	85.00	71.80	5.57
Solapur	19.20	38.04	24.80	81.00	74.00	6.02

Table 3: Correlation of adult white grub emergence with abiotic factors in five districts

District	Rainfall	Max. temp.	Min. temp.	Morning RH	Evening RH	Evaporation
Kolhapur	0.19*	-0.23	-0.97	0.04*	0.10*	-0.33
Sangli	0.43*	-0.76	-0.98	0.91*	0.92*	-0.37
Satara	0.62*	-0.81	-0.83	0.17*	0.88*	-0.72
Pune	0.84*	-0.38	-0.89	0.35*	0.82*	-0.45
Solapur	0.29*	-0.79	-0.99	0.49*	0.69*	-0.78

Note: * Significant at 5%, (-) non-significant, as reported in the supplied research data.

The distribution pattern observed in the present investigation demonstrated that white grub assemblages were not uniform across Western Maharashtra. Kolhapur supported the greatest species richness, whereas Pune and Solapur had a much narrower species composition. The presence of *H. serrata* in all five districts and its dominance in four districts suggested that this species was particularly successful across the climatic gradient covered by the study. *P. dionysius* was especially abundant in Sangli and also formed an important component of the Solapur white grub assemblage. The overall collection of 4,342 adults comprised 1,104 *H. serrata*, 632 *P. dionysius*, 610 *H. fissa*, 471 *A. bengalensis* and 321 *H. farinosa*, with the remaining species occurred in lower numbers. The concentration of abundance in a limited number of species indicated that the white grub complex was composed of both widespread species and species with more restricted local occurrence. The greater diversity in Kolhapur may reflected the combination of relatively favourable moisture conditions, varied habitats and availability of host plants in the surveyed localities. The climatic relationships further indicated that adult emergence was closely associated with moisture

availability. Rainfall and relative humidity consistently showed positive relationships with adult abundance, whereas temperature and evaporation showed negative relationships. Similar seasonal responses of scarabaeid beetles to rainfall and climatic conditions have been reported by Dashad *et al.* (2008) ^[6], Kumar *et al.* (2009) ^[10], Sharma *et al.* (2011) ^[12], Khanal *et al.* (2012) ^[8], and Oliveira and Frizzas (2017) ^[11]. The present results therefore provided a useful baseline for understanding the distribution and seasonal activity of white grub species in the contrasting agro-climatic environments of Western Maharashtra.

Species composition

Nineteen species were recorded in total: *Holotrichia serrata*, *H. farinosa*, *H. fissa*, *H. rubroflava*, *Sophrops karschi*, *Apogonia* sp., *Maladera* (*Maladera*) sp., *Alissonotum piceum*, *Phyllognathus dionysius*, *Protaetia* (*Indoprotea*) *alboguttata*, *Hybosorus illigeri*, *Anomala bengalensis*, *A. dorsalis*, *A. rugosa*, *Anomala* sp. 1, *Anomala* sp. 2, *Adoretus* (*Adoretus*) sp. 1, *Adoretus* (*Adoretus*) sp. 2 and *Parastasia rufopicta*. Their occurrence across the surveyed districts demonstrates the rich scarabaeid fauna of Western

Maharashtra. The predominance of Melolonthinae is in agreement with earlier observations of the importance of this subfamily within white grub complexes.

Summary and Conclusion

Summary

The present study documented the distribution pattern of white grub species in five districts of Western Maharashtra during 2025-26. A total of 4,342 adult beetles representing nineteen species under five subfamilies were recorded. Melolonthinae was the most represented subfamily. Kolhapur recorded the highest species richness and adult abundance followed by Sangli, Pune, Satara and Solapur in terms of adult abundance.

Holotrichia serrata was the most abundant species overall, with 1,104 adults, and remained dominant in Kolhapur, Satara, Pune and Solapur. *Phyllognathus dionysius* was dominant in Sangli. *H. fissa*, *A. bengalensis* and *H. farinosa* were also important components of the regional white grub complex. The distribution pattern indicated substantial differences in species composition among districts, while several species occurred across contrasting agro-climatic environments.

Adult emergence generally commenced after rainfall and increased during the monsoon period. Rainfall and relative humidity showed positive associations with adult abundance in all five districts, whereas maximum temperature, minimum temperature and evaporation showed negative associations. The results indicated that rainfall and atmospheric moisture were important factors associated with adult emergence, while warmer and drier conditions were associated with reduced beetle activity.

Conclusion

The investigation revealed rich white grub diversity in Western Maharashtra, with nineteen species recorded from the five surveyed districts. The highest diversity and abundance were recorded in Kolhapur, while *H. serrata* was the most widespread and abundant species and dominated four of the five districts. *P. dionysius* was dominant in Sangli. The consistent positive association of rainfall and relative humidity with adult emergence and the negative association of temperature and evaporation indicated the importance of abiotic conditions in shaping the seasonal distribution and abundance of white grub beetles. The findings provided baseline information for continued monitoring of white grub species under the varied agro-climatic conditions of Western Maharashtra.

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