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FIRST RECORD ON POPULATION DYNAMICS OF *SOLENOPSIS GEMINATA* (FABRICIUS) (HYMENOPTERA: FORMICIDAE) IN SELECTED COASTAL DISTRICTS OF TAMIL NADU FROM INDIA

T. Nalini* and S. Sasinathan

Department of Entomology, Faculty of Agriculture, Annamalai University, Chidambaram - 608002, Tamil Nadu, India

*Corresponding author email: nalini_jk@yahoo.com

Abstract

A Survey was conducted to observe the population dynamics of *Solenopsis geminata* in selected coastal districts of Tamil Nadu in relation to abiotic factors. This is the maiden attempt to record the population dynamics of *Solenopsis geminata* in selected coastal districts of Tamil Nadu from India. *Solenopsis geminata* mounds were present in Faculty of Agriculture, Administration area, Thiruvetkulam area, Sivapuri east, Sivapuri west, Sivapuri south, Sivapuri north, Kilagundalapadi south, Kilagundalapadi north, Therkumangudi west, Panchanthikulam east, Panchanthikulam west, Ayakkaranpulam and Maruthur during twelve months. In Therkumangudi north they were totally absent in all twelve months. Maximum density of *Solenopsis geminata* mounds occurred during March followed by July, November, December, January, May, June and October in locations of Cuddalore district. During October, November and December their mound density did not fallen down. In locations of Nagapattinam district maximum mound density of *Solenopsis geminata* occurred during May. Minimum number of mounds occurred during April.

***Keywords*:** *Solenopsis geminata*, density, mounds, first record, abiotic factors

Introduction

Alien species are non-native or exotic organisms that occur outside their natural adapted habitat and dispersal potential. Some of the alien species become invasive when they are introduced deliberately or unintentionally outside their natural habitats into new areas where they express the capability to establish, invade and outcompete native species (Sujay *et al*., 2010).

Solenopsis geminata often colonizes disturbed habitats (Perfecto, 1991). It is capable of colonizing most types of soils. It occurs in shaded orchards and woods (Wilson and Brown, 1958), as well as open areas. Habitat types vary greatly (Way *et al*., 1998). This species prefers low to mid-elevations below 1500 feet (Perfecto, 1994), but has been reported to occur at 3000 ft (Smith, 1936). It prefers mild winter temperatures and high humidity (Snelling, 1975). Foraging occurs in the temperature range of 77 to 90°F, with extreme temperature limits that prevent foraging below 36°F and above 122°F (George and Narendran, 1987). *Solenopsis geminata* species prefers open areas and avoids, or is displaced by other ants in, dense shaded areas. Colonies require locations with full sun; brood chambers will be moved within 24 hours if they become shaded (Perfecto and Vandermeer, 1996). Bharti *et al.* (2016) reported on the *Solenopsis geminata* distribution in India in Andaman and Nicobar islands, Arunachal pradesh, Assam, Bihar, Goa, Gujarat, Himachal Pradesh, Jammu and Kashmir, Jharkhand, Karnataka, Kerala, Maharashtra, Manipur, Meghalaya, Mizoram, Nagaland, Orissa, Punjab, Rajasthan, Sikkim, Tamil Nadu, Tripura and West Bengal.

Cokendolpher and Francke (1985) studied the temperature preferences of *Solenopsis geminata* workers with brood along a thermal gradient. *Solenopsis geminata* at 0% RH preferred temperatures from 22 to 29ºC, and at 100% RH temperatures preferred was 25 to 32ºC. Optimal foraging activity of *Solenopsis geminata* was tested by Veeresh (1990) from 25.5ºC to 33ºC and identified the critical maximum and minimum temperatures (unable to move resulting in death if temperatures maintained) being 49.8ºC and 2.2ºC respectively. This contrasts with Hood and Tschinkel (1990) whom reported lower resistance to desiccation of *Solenopsis geminata* than *Solenopsis invicta* (30ºC and a range of humidities) and suggested *Solenopsis gem*inata is unable to forage in very hot areas as long as *Solenopsis invicta*. Wuellner and Saunders (2003) pointed that *Solenopsis geminata* foraging was not recorded below 15ºC in Texas whereas *Solenopsis invicta* foraged at ambient temperatures down to 10ºC. Morrison et al. (2005) similarly stated as Korzukhin *et al*. (2001) whom used colony growth and alate production as determinants of colony establishment under a global warming scenario. Climate change data from the Vegetation-Ecosystem Modeling and Analysis Project (VEMAP) were used to simulate global warming trends. The model predicted that any increase in *Solenopsis invicta's* range would be first observed in the states of Oklahoma, Arkansas, Tennessee, and Virginia. The climate change model also predicted that red imported fire ant expanded its current range by 5% within the following 40-50 years. Moreover, by 2100, red imported fire ants were predicted to have increased their total range in the U.S. by 21%. Keeping in mind the importance of *Solenopsis geminata* management the present investigation was initiated to study the population dynamics of *Solenopsis geminata* in selected coastal districts of Tamil Nadu in relation to abiotic factors.

Materials and Methods

Survey for density of *Solenopsis geminata* was conducted in five places viz., Annamalainagar, Sivapuri, Kilagundalapadi, Therkumangudi and Vedaranyam (Four locations in each place) of Cuddalore and Nagapattinam districts respectively in Tamil Nadu during January to December 2017.

To assess the mound density of *Solenopsis geminata*, once at a location, 15 numbers of plots were randomly selected. Walk was made in random number of places in random direction within each plot. The plots were 5m^2 and were searched for approximately 30 minutes for *Solenopsis geminata* mounds (per location). The number of mounds per plot were noted at fortnightly intervals. Also the influence of abiotic factors like temperature and rainfall on the density of *Solenopsis geminata* were studied.

Results and Discussion

This is the maiden attempt to record the population dynamics of *Solenopsis geminata* in selected coastal districts of Tamil Nadu from India. Locationwise results obtained from the density of *Solenopsis geminata* at Annamalainagar are furnished in Table 1.

From the Table 1, it could be inferred that in Faculty of Agriculture maximum number of mounds of *Solenopsis geminata* were observed in the month of July (29.00) followed by August (4.95), January (4.55) and December (3.45). Minimum number of mounds were observed in the month of November (0.35) followed by October (1.10).

In Administration area, maximum number of mounds were observed in the month of January (4.05) followed by September (2.95), October (2.30), December (2.25) and minimum number of mounds were observed in the month of April (0.85) followed by November (0.95).

In Faculty of medicine, maximum number of mounds were observed in the month of December (1.9) followed by May and August (1.05), March (0.75), October (0.50) and minimum number of mounds were observed in November (0.10). During the months of January and September the mounds were absent.

Maximum number of mounds were observed in Thiruvetkulam area in the month of July (1.05) followed by December (0.80), February (0.75), March and April (0.70) and minimum number of mounds were observed in the month of September and November (0.05) followed by June (0.15).

At Annamalainagar during January, April, May, June, July, September, November and December the maximum, minimum temperature and rainfall were 29.7°C, 20.6°C and 4.11mm; 37.1°C, 33.3°C and 0.00mm; 37.6°C, 26.9°C and 0.01mm; 36.8°C, 26.2°C and 2.71mm; 36.1°C, 25.6°C and 3.72 mm; 33.1°C, 25.0°C and 1.62mm; 29.4°C, 23.9°C and 25.42mm ; 28.6°C, 22.3°C and 7.45mm respectively (Annexure I).

Location wise results obtained from the density of *Solenopsis geminata* at Sivapuri are furnished in Table 2.

Mounds of *Solenopsis geminata* were observed at Sivapuri east at maximum during the month of December (1.65) followed by October (1.60), September (1.50) and May (1.15). Minimum number of mounds were observed during the month of February (0.25) followed by January (0.30).

Maximum number of mounds were observed in Sivapuri west area during month of July (3.75) followed by March (1.65), June (1.50), December (1.35) and minimum number of mounds were observed in the month of January and February (0.35) followed by April (0.45).

Maximum number of mounds were observed in Sivapuri south area in the month of May (2.75) followed by March (2.30), December (1.45), April (1.35) and minimum number of mounds were observed in the month of June (0.10) followed by August, October and November with same number of mounds (0.50).

In Sivapuri north area, maximum number of mounds were observed in the month of October (2.80) followed by December (2.55), September (2.35), November (1.95) and minimum number of mounds were observed in the month of February (0.10) followed by January (0.50).

At Sivapuri during January, February, May, June, July, October and December the maximum, minimum temperature and rainfall were 29.7°C, 20.6°C and 4.11mm; 30.2°C, 19.6°C and 0.00mm; 37.6°C, 26.9°C and 0.01mm; 36.8°C, 26.2°C and 2.71mm; 36.1°C, 25.6°C and 3.72mm; 32.4°C, 24.7°C and 12.0mm; 28.6°C, 22.3°C and 7.45mm respectively (Annexure I).

Locationwise results obtained from the density of *Solenopsis geminata* at Kilagundalapadi are furnished in Table 3.

From the table 8, it could be inferred that in Kilagundalapadi east maximum number of mounds of *Solenopsis geminata* were observed in the month of November (1.15) followed by October (1.05), December (1.00) and March (0.90). Minimum numbers of mounds were observed in the month of February and May (0.25). The mounds were absent during January and June to August months.

In Kilagundalapadi west, maximum number of mounds were observed in the month of June (3.30) followed by March (0.70), April (0.55), July (0.35) and the mounds were absent in the months of January, February, August, September and November (0.00). Minimum number of mounds were present in October (0.05).

In Kilagundalapadi south, maximum number of mounds were observed in the month of March (4.40) followed by May (3.80), April (2.60), October (2.55) and minimum number of mounds were observed in the month of February (0.15) followed by September and November with the same number of mounds (1.05).

Maximum number of mounds were observed in Kilagungalapadi north in the month of March (3.35) followed by May (2.50), August (1.90), July (1.70) and minimum number of mounds were observed in the month of November (0.60) followed by September (0.70).

At Kilagundalapadi during January, February, March, May, June and November the maximum, minimum temperature and rainfall were 29.7°C, 20.6°C and 4.11mm; 30.2°C, 19.6°C and 0.00mm; 32.9°C, 23.2°C and 0.41mm; 37.6°C, 26.9°C and 0.01mm; 36.8°C, 26.2°C and 2.71mm; 29.4°C, 23.9°C and 25.42mm respectively (Annexure I).

Locationwise results obtained from the density of *Solenopsis geminata* at Therkumangudi are furnished in Table 4.

Mounds of *Solenopsis geminata* were observed at Therkumangudi east to the maximum in the month of November (1.10) followed by April (0.85), May (0.70) and June (0.40). Absence of mounds were observed in the months of January to March and July to September (0.00). Minimum number of mounds were found in October (0.30).

Maximum number of mounds were observed in Therkumangudi west area in the month of March (2.60) followed by May (2.55), January (1.85), April (1.70) and minimum number of mounds were observed in the month of December (0.30) followed by June (0.40) (Table 9).

Maximum number of mounds were observed in Therkumangudi south area in the month of March (2.45) followed by May (2.10), July (1.95), January; April; August (1.65) and minimum number of mounds was observed in the month of June (0.05). Absence of mound observed in November.

There were no mounds of *Solenopsis geminata* in Therkumangudi north thoughout the year.

At Therkumangudi during March, May, June, October, November and December the maximum, minimum temperature and rainfall were 32.9°C, 23.2°C and 0.41mm; 37.6°C, 26.9°C and 0.01mm; 36.8°C, 26.2°C and 2.71mm; 32.4°C, 24.7°C and 12.0mm; 29.4°C, 23.9°C and 25.42mm; 28.6°C, 22.3°C and 7.45mm respectively (Annexure I).

Locationwise results obtained from the density of *Solenopsis geminata* at Vedaranyam are furnished in Table 5.

From the table 10, it could be inferred that; in Panchanthikulam east maximum number of mounds of *Solenopsis geminata* were observed in the month of May (11.07) followed by June (9.98), July (8.92), August (7.66). Minimum number of mounds were observed in the month of April (3.23) followed by February (4.40).

In Panchanthikulam west, maximum number of mounds were observed in the month of May (9.19) followed by June (8.43), July (7.51), August (6.96) and minimum number of mounds were observed in the month of April (2.68) followed by February (3.23).

In Ayakkaranpulam, maximum number of mounds were observed in the month of May (12.41) followed by June (11.84), July (10.81), March (9.79) and minimum number of mounds were observed in the month of April (5.11) followed by February (6.31).

Maximum number of mounds were observed in Maruthur on month of May (14.26) followed by June (13.83), July (12.15), March (11.19) and minimum number of mounds were observed in the month of April (6.92) followed by September (7.19).

At Vedaranyam during February, March, April, May, June, July the maximum, minimum temperature and rainfall were 33.6°C, 19.5°C and 0.00mm; 35.2°C, 24.51°C and 1mm; 40.4°C, 21.3°C and 0.06mm; 38.0°C, 21.3°C and 1.90mm; 38.8°C, 27.2°C and 0.6mm; 38.5°C, 26.7°C and 1.5mm respectively (Annexure II).

Fire ants (*Solenopsis*) are common and widely distributed in Brazil. In selected areas, population densities can be as great as those in the United States (Wojcik, 1983, Banks *et al*., 1985). Nevertheless, result of this survey indicated that *Solenopsis geminata* are much more common along roadsides in the United Sates than they are in central Brazil. Monogyne *Solenopsis invicta* in the southeastern United States occurred at more sites, in higher densities, and in larger mounds than their counteroarts in Mato Grosso do Sul, Brazil.

In similarity with present findings on recordings of maximum densities of *Solenopsis geminata* at Vedaranyam and Annamalainagar many studies registered the same in different parts of the world like, in Mexico, nest densities of more than 2500 occupied mounds/ha (>1000 mounds/acre) have been recorded for polygyne forms (MacKay *et al.*, 1990), 50 times the density of monogyne forms in the same area. In Florida, densities are reported from 4 to 20 nests/ha (McInnes and Tschinkel, 1995), and in Texas up to 90 mounds/ha (Porter *et al*., 1988). Densities of up to 6000 nests/ha have been reported in India (Veeresh, 1990) and are probably polygynous forms. Carroll and Risch (1983) reported densities of 0.06 and 1.6 mounds/plot in areas of low and high grass seed abundance in Mexico (equates to 12,320 mounds/ha). The number of workers in a nest can vary enormously, from 4000 to hundreds of thousands (Taber, 2000). Way *et al*. (1998) estimated up to 100 000 *S. geminata* workers in a large nest and at least 500 000 in 100 metres of rice field edge. Veeresh (1990) reported colonies to contain from 4139 to 111 376 workers.

Savitha *et al*. (2008) reported that *Solenopsis geminata* and few other ant species were commonly found in all the sites surveyed by them. This shows that *Solenopsis geminata* particularly, is competent and can adapt to the changing conditions. This species is omnivorous in diet and studies carried out by Risch and Caroll (1982) have also shown that they are abundantly found in disturbed ecosystems. Moreover, it was found to frequently reside in human structures, which substantiates its presence in most sites. The two abundantly found *Solenopsis* and *Monomorium* clearly showed two distinct trends: abundance of *Solenopsis geminata* increased with increase in disturbance while that of *Monomorium indicum* increased in less disturbed areas across the sites. Thus, *Solenopsis geminata* could be used as an indicator for disturbed sites and *Monomorium indicum* as an indicator for relatively less disturbed sites. This is in accordance with the present study results in which all the locations of Vedaranyam were recorded with the high density of *Solenopsis geminata* mounds.

In accordance with present findings Nalini (2017) also recorded *Solenopsis geminata* in various locations of Vedaranyam which affected crops, cattles and human beings as their density was more than other locations in other two coastal districts of Tamil Nadu. She also added that this as sign of non – native species becoming invasive, climatic conditions and soil type favoured its establishment and spread.

In the present study results, low densities of *Solenopsis geminata* at Therkumangudi and their complete absence in few locations of four other places recorded may be due to less suitable microclimate and biocontrol agents. This is in accordance with Jouvenaz *et al*., 1981; Jouvenaz, 1986; Wojcik, 1986 whom stated that low densities of fire ants in Brazil are consistent with the hypothesis that natural enemies limit fire ant populations in their native habitat. Certainly, biological control agents (pathogens, parasites, predators) are much more common in Brazil than they are in the United States. So far, researchers have found eight or nine specific pathogens that together infect 10-20% of all Brazilian fire ant colonies. Ness and Bronstein (2004) also reported that *Solenopsis japonica* has increased in population due to climate changes.

Fluctuations in the *Solenopsis invicta* mound density in different locations are due to differences in the availabity of types of food resources which will affect them predominantly. This possibility has not been carefully investigated and deserves further attention; however, *Solenopsis invicta* is very general in its feeding habits (Tennant and Porter, 1991). This supports the present study results.

From the present findings it is revealed that maximum density of *Solenopsis geminata* mounds occurred during March followed by July, November, December, January, May, June and October in locations of Cuddalore district. In these months mound density of *Solenopsis geminata* fluctuated by high temperature combined with rainfall. If there was less intermittent rainfall their mound density shooted up. Even with high rainfall (October, November, December) their mound density did not fallen down because they occurred with gaps. Thus during April and February in none of the locations mound density was maximum because of absence of rainfall even with high temperatures.

In all locations of Vedaranyam maximum mound density of *Solenopsis geminata* occurred during May because of high temperature and intermittent rainfalls. Minimum number of mounds occurred during April when the temperature was so high than all the other months with less rainfall. This shows temperature above 40^0C did not favoured *Solenopsis geminata* mounds.

Present study results were supported by several studies around the world which have looked directly or indirectly at *Solenopsis geminata* foraging activity or survival in relation to temperature. Rani and Narendran (cited in Veeresh, 1990) reported optimal foraging activity from 25.5 to 33°C with the critical maximum and minimum temperatures (unable to move resulting in death if temperatures maintained) being 49.8 and 2.2°C respectively. *Solenopsis geminata* foraging was not recorded below 15°C in a study in Texas whereas *Solenopsis invicta* foraged at ambient temperatures down to 10°C (Wuellner and Saunders, 2003). Braulick *et al*. (1988) examined high temperature tolerance of four *Solenopsis* species and found that workers of *Solenopsis geminata* tended to be more resistant to desiccation (tested range 25 to 38°C and zero RH) than *Solenopsis invicta*, *Solenopsis aurea*, and *Solenopsis xyloni,* which may reflect their larger body size (especially of the major workers). This contrasts with Hood and Tschinkel (1990) who reported lower resistance to desiccation of *Solenopsis geminata* than *Solenopsis invicta* (30°C and a range of humidities) and suggested *Solenopsis geminata* is unable to forage in very hot areas for as long as *Solenopsis invicta*. Cokendolpher and Francke (1985) studied the temperature preferences of workers with brood along a thermal gradient. *Solenopsis geminata* at 0% RH preferred temperatures from 22 to 29°C, and at 100% RH temperatures of 25 to 32°C. This range is higher than that reported in a similar study for a temperate ant, *Myrmica rubra*, in England which preferred 19 to 21°C (Brown cited in Cokendolpher and Francke, 1985). In Malaysia foraging activity was higher during .cooler. Temperatures at night (averaging 25°C) than during the day (averaging 33°C) (Lee, 2002). The LD50 of *S. geminata* minor workers to exposure to high temperatures for an hour is above 40°C (Francke *et al*., 1985)

Environments with high rainfall reduce foraging time of *Solenopsis geminata* and may reduce the probability of establishment (Cole *et al*., 1992; Vega and Rust, 2001). High rainfall also contributes to low soil temperatures. In high rainfall areas, it may not necessarily be rainfall per se that limits distribution but the permeability of the soil and the availability of relatively dry areas for nests (Chen *et al*., 2002). Conversely, in arid climates, lack of water probably restricts the ant distribution (Ward, 1987; Van Schagen *et al*., 1993; Kennedy, 1998). The above studies supports the present findings.

Similarly Porter *et al*. (1992) whom reported that climatic differences are another important consideration in case of *Solenopsis* density. Mean winter and summer temperatures are respectively 17-21°C (July) and 24- 27°C (January) in Mato Grosso do Sul compared with 7-13°C (January) and 27-28°C (July) for sites in the United States. In other words, sites in Brazil were warmer in the winter and almost as hot in the summer. Annual precipitation in Mato Grosso do Sul ranges between 100 and 160 cm, which is very similar to the 120 -170 cm of rain for the sites in the United States. An important difference is that Mato Grosso do Sul has dry winters (June-August), during which only 9-20 cm of rainfalls. By contrast, their sample sites in the United States averaged 23-43 cm of rain during winter months (December-February). This difference is substantial, but its significance is not clear because monogyne areas around San Antonio, Tex., average only 10 -15 cm of rain during winter months and still have roadside fire ant densities of about 200 mounds/ha.

In the present findings, reason for differences in density of *Solenopsis* mound within the places (i.e. locations) is not known; however, shade effects, cultural practices and presence of biological control agents are likely factors that deserve further attention. This is supported by Porter *et al*. (1992) whom stated that cultural practice is that roadsides in Brazil are generally not mowed; consequently, grass at sites in Brazil was about twice as high as it was in the United States. They found no correlation between mound density and grass height within either country; however, mowing or burning can make grass height much more variable than mound density. Grass at 36% of Brazilian sites was within normal height range for the United States. Most Brazilian sites appeared to be suitable fire ant habitat; however, tall grass clearly limited populations at some locations.

Similarly, in Hawaiian sugarcane fields, *Solenopsis geminata* populations were highest at the open field edges (Chang and Ota, 1976). This species prefers open areas and avoids, or is displaced by other ants in, dense shaded areas (Phillips, cited in Chang and Ota, 1976; Perfecto and Vandermeer, 1996). Colonies require locations with full sun; brood chambers will be moved within 24 hrs if they become shaded (Perfecto and Vandermeer, 1996). In the laboratory, Chang and Ota (1976) found greater damage to plastic tubing at higher soil temperatures (experimental range from 20 to 35°C).

Table 1 : Density of *Solenopsis geminata* at Annamalainagar (January – December 2017)

Month#	NUMBER OF MOUNDS*				WEATHER PARAMETERS		
	Faculty of Agriculture	Administration Area	Faculty of Medicine	Thiruvetkulam Area	Max. Temp. (°C)	Min. Temp. (°C)	Rainfall (mm)
JANUARY	4.55	4.05	0.00	0.60	29.7	20.6	4.11
FEBRUARY	1.95	1.70	0.25	0.75	30.2	19.6	0.00
MARCH	3.05	1.80	0.75	0.70	32.9	23.2	0.41
APRIL	1.35	0.85	0.35	0.70	37.1	33.3	0.00
MAY	2.10	1.95	1.05	0.45	37.6	26.9	0.01
JUNE	2.60	1.10	0.15	0.15	36.8	26.2	2.71
JULY	29.00	1.25	0.15	1.05	36.1	25.6	3.72
AUGUST	4.95	1.45	1.05	0.60	33.9	25.9	7.75
SEPTEMBER	2.95	2.95	0.00	0.05	33.1	25.0	1.62
OCTOBER	1.10	2.30	0.50	0.50	32.4	24.7	12.0
NOVEMBER	0.35	0.95	0.10	0.05	29.4	23.9	25.42
DECEMBER	3.45	2.25	1.90	0.80	28.6	22.3	7.45

Mean of two counts * Mean of fifteen counts

Table 2 : Density of *Solenopsis geminata* at Sivapuri (January – December 2017)

Month#	NUMBER OF MOUNDS*				WEATHER PARAMETERS		
	Sivapuri East	Sivapuri West	Sivapuri South	Sivapuri North	Max. Temp. (°C)	Min. Temp. (°C)	Rainfall (mm)
JANUARY	0.30	0.35	0.75	0.50	29.7	20.6	4.11
FEBRUARY	0.25	0.35	0.95	0.10	30.2	19.6	0.00
MARCH	1.00	1.65	2.30	0.85	32.9	23.2	0.41
APRIL	0.35	0.45	1.35	0.70	37.1	33.3	0.00
MAY	1.15	1.20	2.75	1.70	37.6	26.9	0.01
JUNE	0.45	1.50	0.10	0.65	36.8	26.2	2.71
JULY	0.90	3.75	0.60	1.60	36.1	25.6	3.72
AUGUST	0.80	0.65	0.50	1.35	33.9	25.9	7.75
SEPTEMBER	1.50	1.05	0.80	2.35	33.1	25.0	1.62
OCTOBER	1.60	1.30	0.50	2.80	32.4	24.7	12.0
NOVEMBER	1.10	0.80	0.50	1.95	29.4	23.9	25.42
DECEMBER	1.65	1.35	1.45	2.55	28.6	22.3	7.45

Mean of two counts * Mean of fifteen counts

Table 3 : Density of *Solenopsis geminata* at Kilagundalapadi (January – December 2017)

Month#	NUMBER OF MOUNDS*				WEATHER PARAMETERS		
	Kilagundalapadi East	Kilagundalapadi West	Kilagundalapadi South	Kilagundalapadi North	Max. Temp. (°C)	Min. Temp. (°C)	Rainfall (mm)
JANUARY	0.00	0.00	1.45	1.00	29.7	20.6	4.11
FEBRUARY	0.25	0.00	0.15	0.75	30.2	19.6	0.00
MARCH	0.90	0.70	4.40	3.35	32.9	23.2	0.41
APRIL	0.35	0.55	2.60	1.70	37.1	33.3	0.00
MAY	0.25	0.30	3.80	2.50	37.6	26.9	0.01
JUNE	0.00	3.30	1.65	0.90	36.8	26.2	2.71
JULY	0.00	0.35	1.90	1.70	36.1	25.6	3.72
AUGUST	0.00	0.00	1.85	1.90	33.9	25.9	7.75
SEPTEMBER	0.30	0.00	1.05	0.70	33.1	25.0	1.62
OCTOBER	1.05	0.05	2.55	1.40	32.4	24.7	12.0
NOVEMBER	1.15	0.00	1.05	0.60	29.4	23.9	25.42
DECEMBER	1.00	0.30	1.65	1.10	28.6	22.3	7.45

Mean of two counts * Mean of fifteen counts

Table 4 : Density of *Solenopsis geminata* at Therkumangudi (January – December 2017)

Month#	NUMBER OF MOUNDS*				WEATHER PARAMETERS		
	Therkumangudi East	Therkumangudi West	Therkumangudi South	Therkumangudi North	Max. Temp. (°C)	Min. Temp. (°C)	Rainfall (mm)
JANUARY	0.00	1.85	1.65	0.00	29.7	20.6	4.11
FEBRUARY	0.00	1.50	0.40	0.00	30.2	19.6	0.00
MARCH	0.00	2.60	2.45	0.00	32.9	23.2	0.41
APRIL	0.85	1.70	1.65	0.00	37.1	33.3	0.00
MAY	0.70	2.55	2.10	0.00	37.6	26.9	0.01
JUNE	0.40	0.40	0.05	0.00	36.8	26.2	2.71
JULY	0.00	0.70	1.95	0.00	36.1	25.6	3.72
AUGUST	0.00	1.20	1.65	0.00	33.9	25.9	7.75
SEPTEMBER	0.00	0.50	0.40	0.00	33.1	25.0	1.62
OCTOBER	0.30	0.50	0.30	0.00	32.4	24.7	12.0
NOVEMBER	1.10	0.95	0.00	0.00	29.4	23.9	25.42
DECEMBER	0.40	0.30	1.30	0.00	28.6	22.3	7.45

Mean of two counts * Mean of fifteen counts

Table 5 : Density of *Solenopsis geminata* at Vedaranyam (January – December 2017)

Month#	NUMBER OF MOUNDS*				WEATHER PARAMETERS		
	Panchanthikulam East	Panchanathi-kulam West	Ayakkaranpulam	Maruthur	Max. Temp. (°C)	Min. Temp. (°C)	Rainfall (mm)
JANUARY	5.63	4.70	8.02	9.75	38.8	26.2	0.6
FEBRUARY	4.40	3.23	6.31	8.55	33.6	19.5	0.00
MARCH	7.63	6.77	9.79	11.19	35.2	24.51	1
APRIL	3.23	2.68	5.11	6.92	40.4	21.3	0.06
MAY	11.07	9.19	12.41	14.26	38.0	21.3	1.90
JUNE	9.98	8.43	11.84	13.83	38.8	27.2	0.6
JULY	8.92	7.51	10.81	12.15	38.5	26.7	1.5
AUGUST	7.66	6.96	8.89	10.27	35.8	25.8	3.6
SEPTEMBER	4.43	4.32	6.45	7.19	34.5	23.9	4.3
OCTOBER	6.78	5.99	8.83	9.89	54.4	25.1	1.1
NOVEMBER	4.65	3.82	6.64	7.99	31.2	23.7	3
DECEMBER	7.41	4.95	9.19	9.43	31.0	23.8	1.2

Mean of two counts * Mean of fifteen counts

ANNEXURE – I

Monthly meteorological data for the year, 2017 recorded at Meteorological weather station, Department of Agronomy, Faculty of Agriculture, Annamalai University, Annamalai Nagar. This also covers Sivapuri, Kilagundalapadi and Therkumangudi.

MONTHS	Weather Parameters		
	Max. Temp. (°C)	Min. Temp. (°C)	Rainfall (mm)
JANUARY	29.7	20.6	4.11
FEBRUARY	30.2	19.6	0.00
MARCH	32.9	23.2	0.41
APRIL	37.1	33.3	0.00
MAY	37.6	26.9	0.01
JUNE	36.8	26.2	2.71
JULY	36.1	25.6	3.72
AUGUST	33.9	25.9	7.75
SEPTEMBER	33.1	25.0	1.62
OCTOBER	32.4	24.7	12.0
NOVEMBER	29.4	23.9	25.42
DECEMBER	28.6	22.3	7.45

ANNEXURE – II

Monthly meteorological data for the year, 2017 recorded from Accuweather for Vedaranyam.

MONTHS	Weather Parameters		
	Max. Temp. (°C)	Min. Temp. (°C)	Rainfall (mm)
JANUARY	38.8	26.2	0.6
FEBRUARY	33.6	19.5	0.00
MARCH	35.2	24.51	1
APRIL	40.4	21.3	0.06
MAY	38.0	21.3	1.90
JUNE	38.8	27.2	0.6
JULY	38.5	26.7	1.5
AUGUST	35.8	25.8	3.6
SEPTEMBER	34.5	23.9	4.3
OCTOBER	54.4	25.1	1.1
NOVEMBER	31.2	23.7	3
DECEMBER	31.0	23.8	1.2

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