Interelationship of relative Humidity ,Rainfall , and Temperature in the proliferation of Aedes *aegypti* (L)

Kaleb Raja Kumar*[1] Philip Samuel [2], Boopathi [3] .

*ICMR-NIE , [2] ICMR-VCRC,, [3] ICMR-NIE

Abstract

In the study conducted in Alandur division , Chennai from June 2016 to May 2017 the proliferation of mosquito Aedes *aegypti* and its relationship to the prevailing temperature ,relative humidity and barometric pressure was analyzed. A total of 800 households in four sub divisions were chosen and searched Inside and outside the premises the immatures were collected along with the ecological significant parameters. . It was found in the months of September to November the stegomyia indices were high even though the combined climatic factors varying and not in increasing mode .This study found that the combined influence of optimum level of climatic factors like temperature rainfall relative humidity and barometric pressure and play effective role , from fecundity rate to adult survival rate of Ae.*aegypti*. It is also observed that not just higher rain fall and high temperature but a moderate rainfall (20 mm to 60 mm) followed by the temperature between 28 ^{o} C to 34 ^{o} C and the relative humidity of 68 to 77 % resulted in higher HI, CI , PI and BI in the study areas.

Key words : climate , proliferation ,parameters effect

*arumaikaleb@gmail.com

Introduction

Aedes ***A****egypti* (L.) is a mosquito that uses natural and artificial containers to undergo its immature development. The number of emerging adults is expected to be regulated by abiotic (rainfall, temperature, and evaporation) and biotic factors (predation, parasitism, competition, and food) interacting in diverse aquatic container habitats, which have varying internal properties (organic matter, microbial communities, and other aquatic insects) depending on their size and shape, location (e.g., under tree canopy, exposed to the sun), and season (e.g., tree leaf-shedding). The population of Ae.*aegypti* is influenced by rainfall in areas where it is markedly seasonal (1) and prevalence of water storage containers has been reported for many urban areas in the tropics. (2)

Aedes *aegypti*, the major vector species of Dengue Fever /DHF in India and is common in most of the urban areas on account of deficient water management ,presence of non degradable tyres and long lasting plastic containers in and around the house , scrap shops and the factories .It breeds in nearly all kinds of water holding containers, viz ., cement tanks ,overhead tanks, underground tanks ,tires ,coolers ,pitchers, discarded containers , etc in which water stagnates for more than a week. Aedes *aegypti* , being a strong anthropophilic mosquito, rests indoors , in closets and other dark places. outside , they rest where it is cool and shady . Ae aegypti breeds almost entirely in man made water receptacles found in and around household construction sites and factories.Natural larval habitats are rare ,but include tree holes ,leaf axles and coconut shells .The population fluctuates with rainfall and humidity..During rainy season , when survival is longer , the risk of virus transmission is greater.

The female mosquito lays eggs in clean water containers in and around houses ,schools and work places. The larvae hatch from

the mosquito eggs , and thrive in the water for about a week .They then change in to a round pupal stage for one or two days after which the adult mosquito emerges , ready to bite. Aedes mosquitoes can fly up to a limited distance of 400 metres, but can spread over vast distances mechanically through in various types of vehicles used by man . The mosquito usually bites during day time .Once the mosquito infected ,it remains so ,for whole life. The female mosquitoes can survive from 8.5 days to 3 weeks under normal temperatures, humidity and nutrition.(3)

Materials and Methods

The survey sheets are in the model of those were used by CRME-ICMR in their field study (2007) and based upon WHO survey guidance for surveillance of dengue Vector.

The study was a year long, started in the month of June ,2016 and passed through heavy and moderate rainfall and dry season till May 2017 . Monthly Temperature, rainfall , relative humidity, and barometric pressure was obtained from IMD ,Chennai.

Study Area

Ward	Houses	Members
156	200	766
157	200	842
158	200	840
164	200	791
Total	800	3239

Water bodies near by the study households

Ward		Locations
156	Manapakkam canal	Dr.Ambedkar nagar 3 street
157	Adayar river	Laxminagr Ambika street
158	Ramar koil Tank	West Kulakarai street
164	Ponnachiamman koil Tank	Amman koil tank street

Entomological Survey methodology is based on the techniques suggested by Focks et al (4).Traditional larval indices (5) and pupal indices (6) is obtained for each four zone in the prevailing ecological and biological factors. Chennai is the fourth largest city in India and lies beside the bay of Bengal.

At this study Alandur division in Chennai is chosen as the area is known to have occurred DF /DHF earlier and further divided in too four zones ie North (Ward 158) South(Ward164) West (Ward 157) and East (Ward 156) and in each zone 200 houses and total 800 households of a sample size were chosen with due permission of searching the premises and their co operation in collecting details of house environment in the questionnaire. (same house searched through out the study) identified for the study .

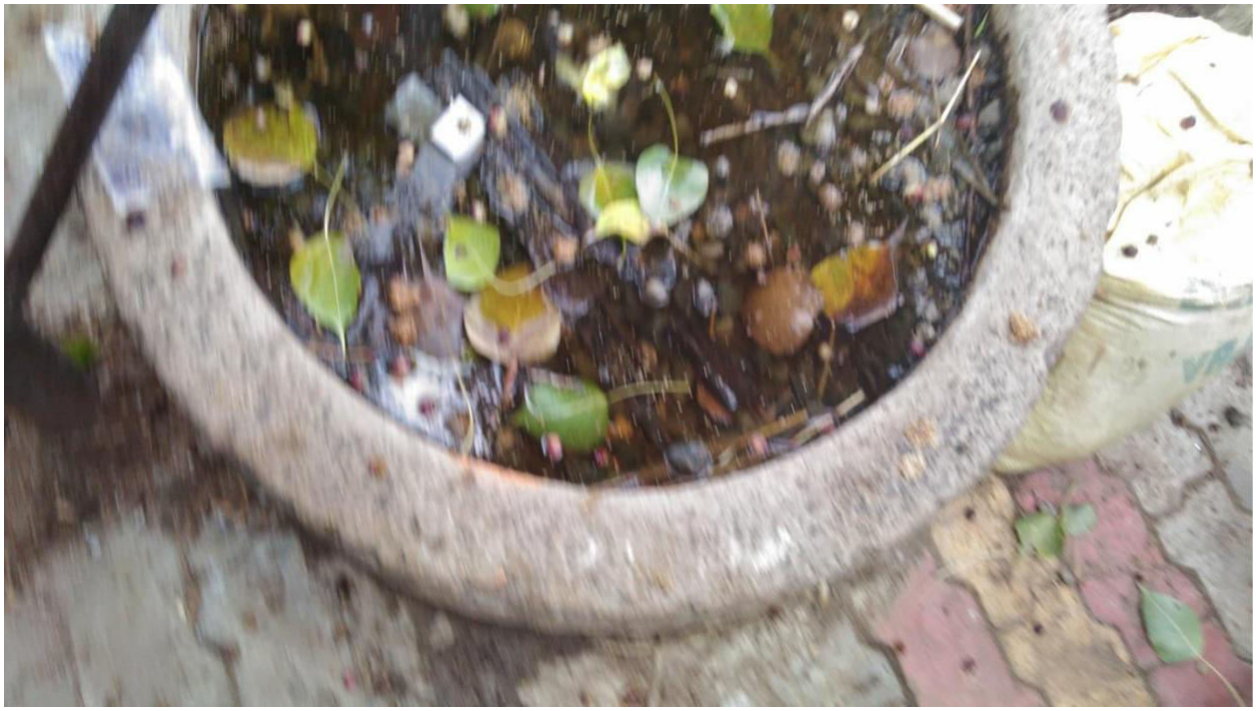
All the relevant data and specimen is collected throughout the year , every week end in all months . A door-to-door entomological survey was carried out to find out the Ae. *aegypti* breeding in all types of water filled containers present in and around houses and their premises. Both immature and mature stages of Aedes mosquitoes were collected. The larval collections were made from each locality with the help of flash-light, by dipping and pipetting methods 7). All kinds of breeding habitats in the study areas like overhead tanks, curing tanks, plastic containers (tubs/ drums/ tanks, iron drums, coolers, curing tanks, daubers, Solid Waste (Disposal Glass, Thermocool box ,Pot, wash basin, Tire dump, Booster pump, Car battery shells ,coconut shells , flower vase ,Cement tank ,Pot, Iron Pipe, Plastic Sheet, Plastic tray, Iron Pot, , disposal pot, Almirah rejected, plastic bucket, dump plastic containers, Plastic bags) and others (flower pots, junk materials, broken glass wares, bottles etc) were screened for the presence of immature stages of Aedes mosquitoes. All larvae and pupae were reared to adult stage for species identification. Meterorological data that was prevailing during collection was obtained from IMD ,Chennai.

In larval survey, different indices were used to record Aedes *aegypti* density level. These indices are House index (HI), container index (CI), Breteau index (BI) and Pupal index (PI)

Results.

The data obtained were tabulated by ward vise.. The breteau Index in the all the wards was not in increasing level during heavy rainfall but in the following month when rainfall is moderate. (Table 1 – 4) . Breteau index is lower in all the wards in the months of January and February when there is no or less rainfall and

temperature too lower than monsoon months. Upon comparing house Index, container Index and pupal index during the rainy monsoon months all indices found to be less during heavy rainfall than during moderate rainfall .It proves that the availability of containers for breeding and enough sunlight and nutrition for larvae and resting place availability for adults.



A water storage stone pit

Discussion

The mosquito Aedes *aegypti* is the primary vector of dengue fever and an extremely synanthropic insect due to its anthropophilic nature and specific reproductive needs .(8) It is abundant in neotropical regions, where environmental factors (e.g., rainfall, temperature, and relative humidity) favor its life cycle .The global distribution of Ae. *aegypti* is strongly influenced by climatic factors, with temperatures of 10°C or lower limiting larval development and adult survival (9)

Optimal temperatures for development, longevity, and fecundity are between 22°C and 32°C (10)- .With higher temperatures in the favorable survival range of *Ae. aegypti*, egg laying time decreases, causing an increase in egg number (11) The immature stages or larval stages of Ae. *aegypti* are found in water-filled habitats, mostly in artificial containers closely associated with human dwellings and often indoors(12) .The population of *Ae. aegypti* is influenced by rainfall in areas where it is markedly seasonal (13)

Tun-Lin et al. (2000)(14) observed that containers with abundant organic matter and located under trees produced larger adult Ae. *aegypti* with faster development and better survival. Our observations revealed a larger number of larvae and pupae of Ae. *aegypti* in containers with leaf litter or algae. The association between the number of Ae. *aegypti* females and total rainfall or mean rainfall showed that rainfall affected the number of females collected in the residences; this effect was greater in the peridomiciliary premises. (14) (15).Thus, it can be deduced that when it rains, mosquitoes tend to find shelter in the vicinity of their breeding grounds; thus, they move toward more sheltered places (16) Rainfall plays an important role in the population density of Aedes sp. (17) Container capacity, water temperature, source of water, and container location, all of which could vary seasonally have been reported as key ecological factors affecting population of Ae. *aegypti* .(18)

Environmental factors and breeding sites had a strong influence on the population dynamics of Ae. aegypti mosquito. Although the population was recorded during the entire year but most of the population was recorded during the rainy season

(19) Ae. *aegypt*i lays its eggs on the inner side of containers above the water line . These eggs are regarded in our model as dry eggs and when they are flooded, for example by rainwater, they usually hatch. *Ae. aegypti* is endophilic (i.e., taking

shelter inside houses) and endophagic (i.e., blood-feeding inside houses), (20)but also moves between indoor and outdoor spaces (21) and takes shelter inside and outside of the premises where open containers and closets of dark cool shady spaces occur .(22).

Conclusion.

It was observed that the proliferation of Aedes *aegypti* from the egg to adult stages all increasing abundantly in the hot wet climate when rainfall temperature relative humidiy and barometric pressure influence together between June to October and the container abundance and water storing practice and the shrub vegetation near by the household too providing the ideal ecosytem for the increased production of Ae.*aegypti* .The prevailing rainfall , temperature and relative humidity or inter relationship between these three factors too providing the suitable niche for the fast development and proliferation of Ae. *aegypti* in the urban environment of study areas in Chennai.

Table 1

Stegomyia Indices and the monthly rainfall , temperature and relative humidity in Ward 156

Ward156 -East Zone						Mean Temperature ^{o} C		Mean Relative Humidity (%)	
Months	HI	Ci	PI	BI	Rainfall(mm)	**Maximum**	**Minimum**	**At 08.30 hrs.(IST)**	**At 17.30 (IST)**
Jun-16	3.0	4.8	5.0	7.5	141.8	35.5	27.6	73	68
July-16	11.1	6.1	6.6	12.1	43.6	35.1	27.4	75	68
Aug-16	4.5	8.7	2.5	5.0	44.3	36.1	27.8	64	60
2016-Sept	12.6	15.0	5.1	9.6	296.6	34.1	26.6	76	68
016-oct	15.7	8.6	6.6	13.2	22.4	34.5	26	71	65
2016-Nov	10.0	22.0	7.0	12.0	50.5	31.7	23.6	77	70
016-Dec	5.5	8.1	2.0	4.0	251.7	30	22.5	80	68
017-Jan	8.0	9.4	2.0	3.5	4.7	30.2	22.7	80	67
017-Feb	3.0	3.9	3.5	6.5	0	31.1	22.3	76	61
017-Mar	3.0	4.2	4.0	4.0	0	33.1	26.2	75	68
017-Apr	3.0	4.8	5.0	7.5	0	35.4	28.3	73	71
017-May	4.0	6.4	4.5	6.5	3	37.6	29.5	62	60

Table 2 . Setegomyia Indices and the monthly rainfall , temperature and relative humidity in Ward 157

Ward 157-West Zone						Mean Temperature ^{o} C		Mean Relative Humidity (%)	
Months	HI	Ci	PI	BI	Rainfall(mm)	**Maximum**	**Minimum**	**At 08.30 hrs.(IST)**	**At 17.30 (IST)**
Jun-16	3.0	6.9	2.5	4.0	141.8	35.5	27.6	73	68
July-16	12.1	11.4	5.1	13.2	43.6	35.1	27.4	75	68
Aug-16	12.2	22.2	6.6	11.7	44.3	36.1	27.8	64	60
2016-Sept	13.8	17.4	3.6	11.7	296.6	34.1	26.6	76	68
016-oct	13.8	9.4	6.6	13.3	22.4	34.5	26	71	65
2016-Nov	8.5	19.7	6.0	12.5	50.5	31.7	23.6	77	70
016-Dec	3.0	9.1	1.0	4.0	251.7	30	22.5	80	68
017-Jan	4.0	9.9	2.0	4.0	4.7	30.2	22.7	80	67
017-Feb	2.5	3.0	3.0	4.5	0	31.1	22.3	76	61
017-Mar	2.0	1.8	2.5	2.0	0	33.1	26.2	75	68
017-Apr	2.0	2.6	4.0	4.5	0	35.4	28.3	73	71
017-May	3.8	3.8	4.3	3.8	3	37.6	29.5	62	60

Table 3 .Setegomyia Indices and the monthly rainfall , temperature and relative humidity in Ward 158

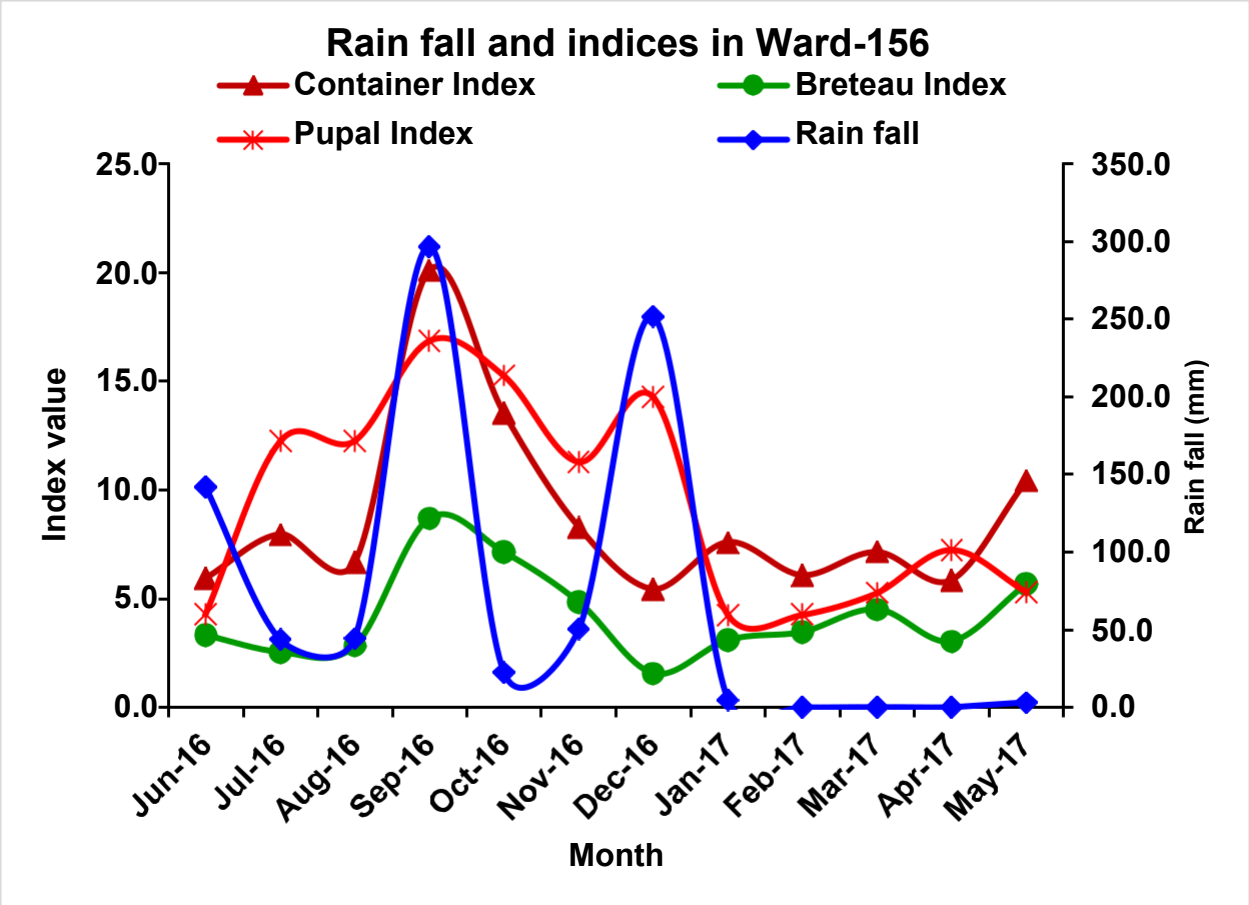
Ward-158-North Zone						Mean Temperature ^{o} C		Mean Relative Humidity (%)	
Months	HI	Ci	PI	BI	Rainfall(mm)	**Maximum**	**Minimum**	**At 08.30 hrs.(IST)**	**At 17.30 (IST)**
Jun-16	2.5	3.0	3.0	4.5	141.8	35.5	27.6	73	68
July-16	7.5	6.5	3.0	6.8	43.6	35.1	27.4	75	68
Aug-16	6.1	8.5	4.6	6.1	44.3	36.1	27.8	64	60
2016-Sept	10.7	20.6	2.6	10.7	296.6	34.1	26.6	76	68
016-oct	15.8	9.2	7.7	13.8	22.4	34.5	26	71	65
2016-Nov	11.6	18.1	8.6	13.1	50.5	31.7	23.6	77	70
016-Dec	3.5	6.4	1.5	3.0	251.7	30	22.5	80	68
017-Jan	3.5	8.0	1.5	4.0	4.7	30.2	22.7	80	67
017-Feb	2.0	2.6	4.0	4.5	0	31.1	22.3	76	61
017-Mar	3.8	3.8	4.3	3.8	0	33.1	26.2	75	68
017-Apr	2.5	2.6	3.0	4.0	0	35.4	28.3	73	71
017-May	2.0	1.8	2.5	2.0	3	37.6	29.5	62	60

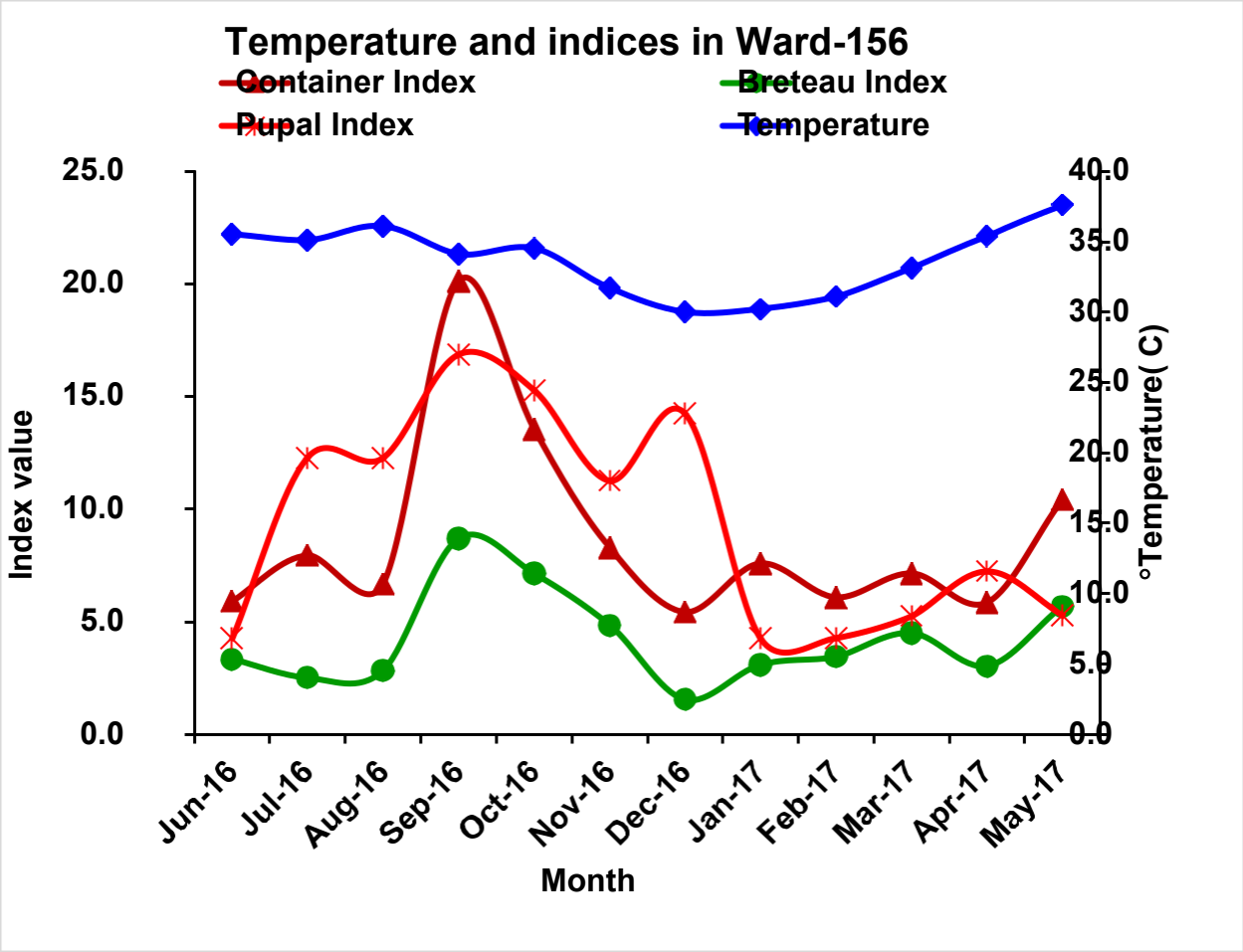
Table 4 Setegomyia Indices and the monthly rainfall , temperature and relative humidity in Ward 164

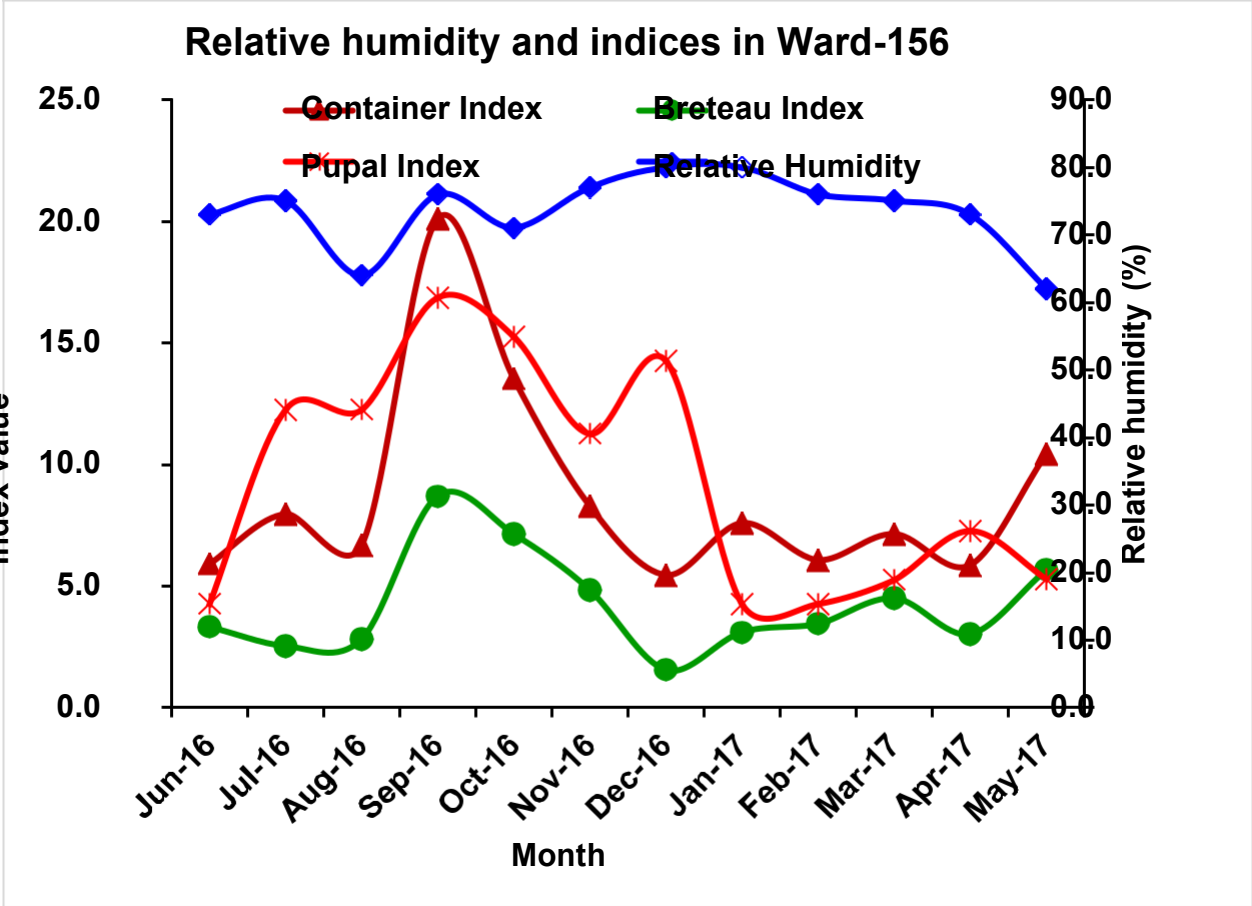
Ward -164-South Zone						Mean Temperature ^{o} C		Mean Relative Humidity (%)	
Months	HI	Ci	PI	BI	Rainfall(mm)	**Maximum**	**Minimum**	**At 08.30 hrs.(IST)**	**At 17.30 (IST)**
Jun-16	4.5	9.8	1.5	7.0	141.8	35.5	27.6	73	68
July-16	7.7	7.5	3.6	8.7	43.6	35.1	27.4	75	68
Aug-16	8.1	10.4	5.1	9.1	44.3	36.1	27.8	64	60
2016-Sept	11.7	19.9	11.2	13.8	296.6	34.1	26.6	76	68
016-oct	13.8	11.0	13.8	18.9	22.4	34.5	26	71	65
2016-Nov	10.7	14.9	12.2	11.7	50.5	31.7	23.6	77	70
016-Dec	2.5	12.8	1.5	6.0	251.7	30	22.5	80	68
017-Jan	4.5	10.4	1.5	4.5	4.7	30.2	22.7	80	67
017-Feb	3.0	4.8	5.0	7.5	0	31.1	22.3	76	61
017-Mar	4.0	6.4	4.5	6.5	0	33.1	26.2	75	68
017-Apr	2.5	9.5	2.0	7.5	0	35.4	28.3	73	71
017-May	3.0	4.2	4.0	4.0	3	37.6	29.5	62	60

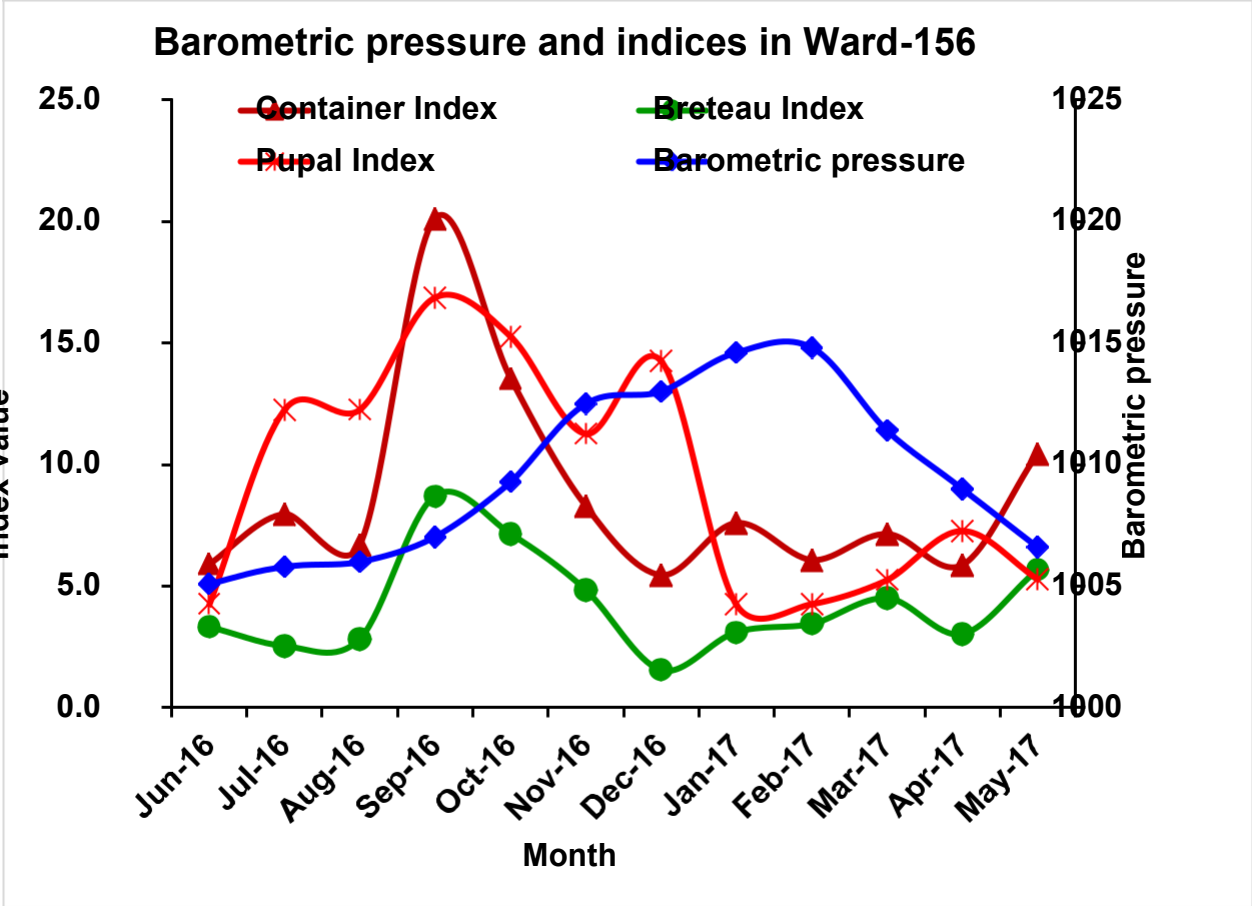
Table 5 Rainfall Temperature and RH in the study areas (Source :IMD)

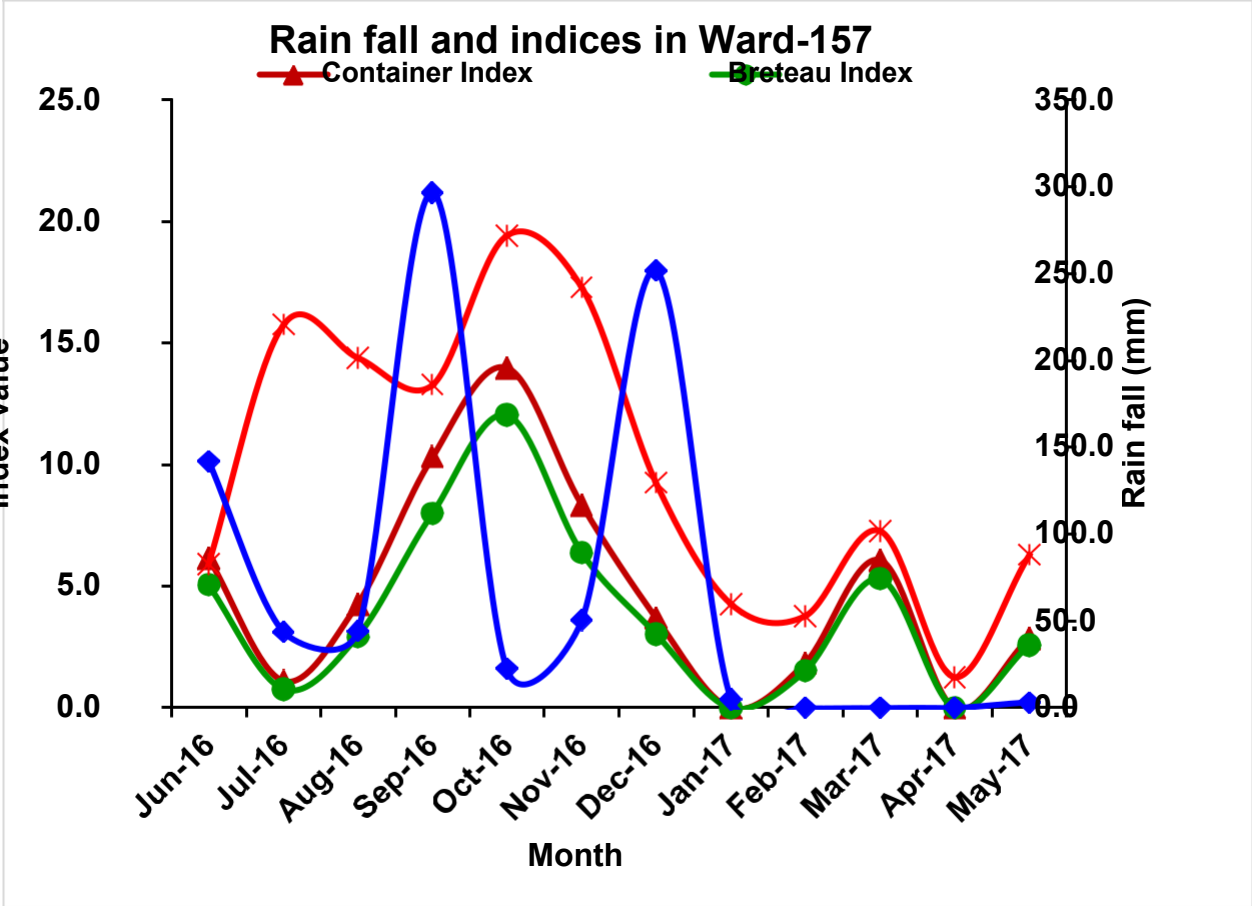
		Mean Temperature °C		Mean Relative Humidity (%)		Barometric Pressure In HPA	
Months	Rainfall(mm)	Maximum	Minimum	At 08.30 hrs.(IST)	At 17.30 (IST)	t.08.30 hrs IS	At 17.50 Hrs.IST
Jun-16	141.8	35.5	27.6	73	68	1005.1	1002.7
July-16	43.6	35.1	27.4	75	68	1005.8	1002.9
Aug-16	44.3	36.1	27.8	64	60	1006	1002.9
2016-Sept	296.6	34.1	26.6	76	68	1007	1003.9
2016-oct	22.4	34.5	26	71	65	1009.3	1006.2
2016-Nov	50.5	31.7	23.6	77	70	1012.5	1009.6
2016-Dec	251.7	30	22.5	80	68	1013	1009.8
2017-Jan	4.7	30.2	22.7	80	67	1014.6	1012
2017-Feb	0	31.1	22.3	76	61	1014.8	1011.9
2017-Mar	0	33.1	26.2	75	68	1011.4	1008.2
2017-Apr	0	35.4	28.3	73	71	1009	1005.1
2017-May	3	37.6	29.5	62	60	1006.6	1003.3

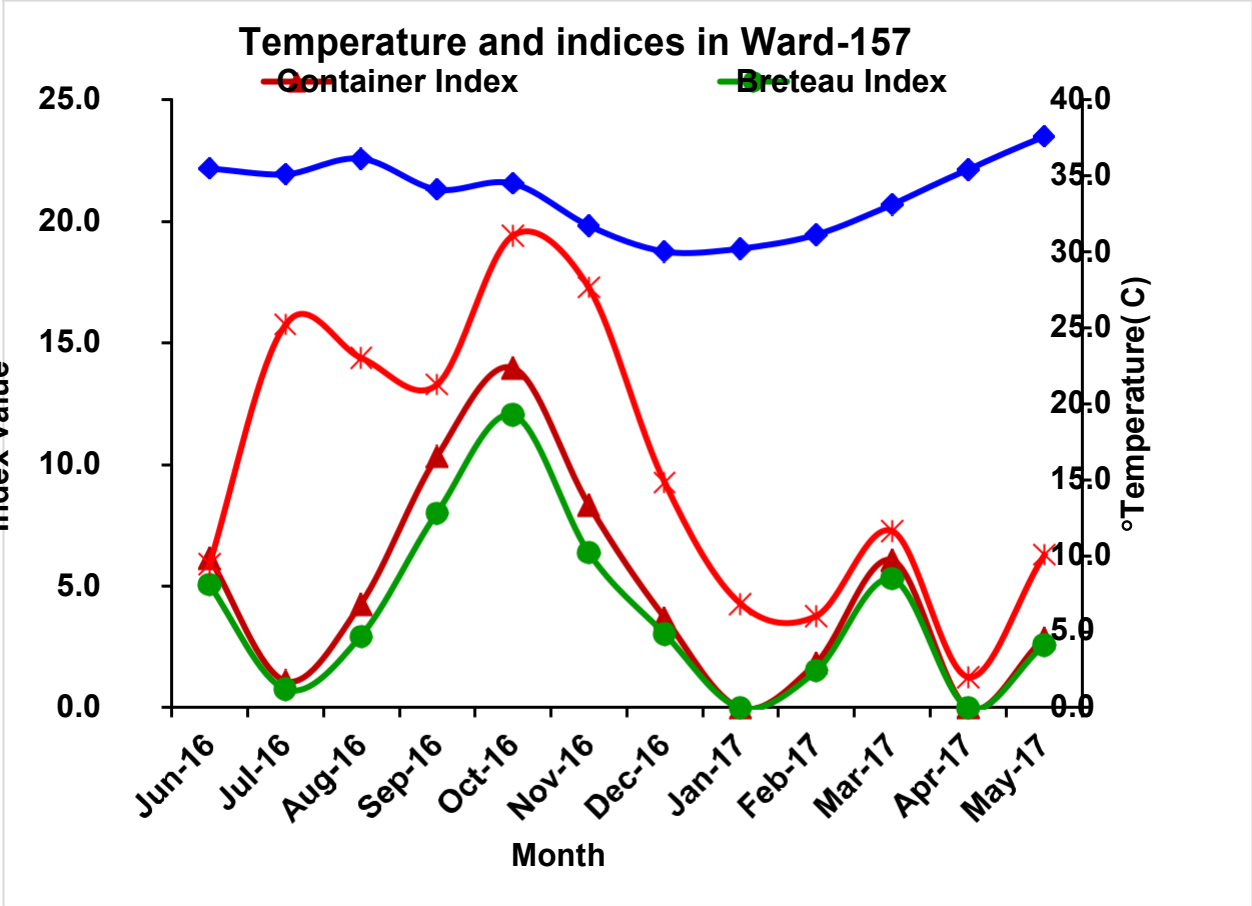


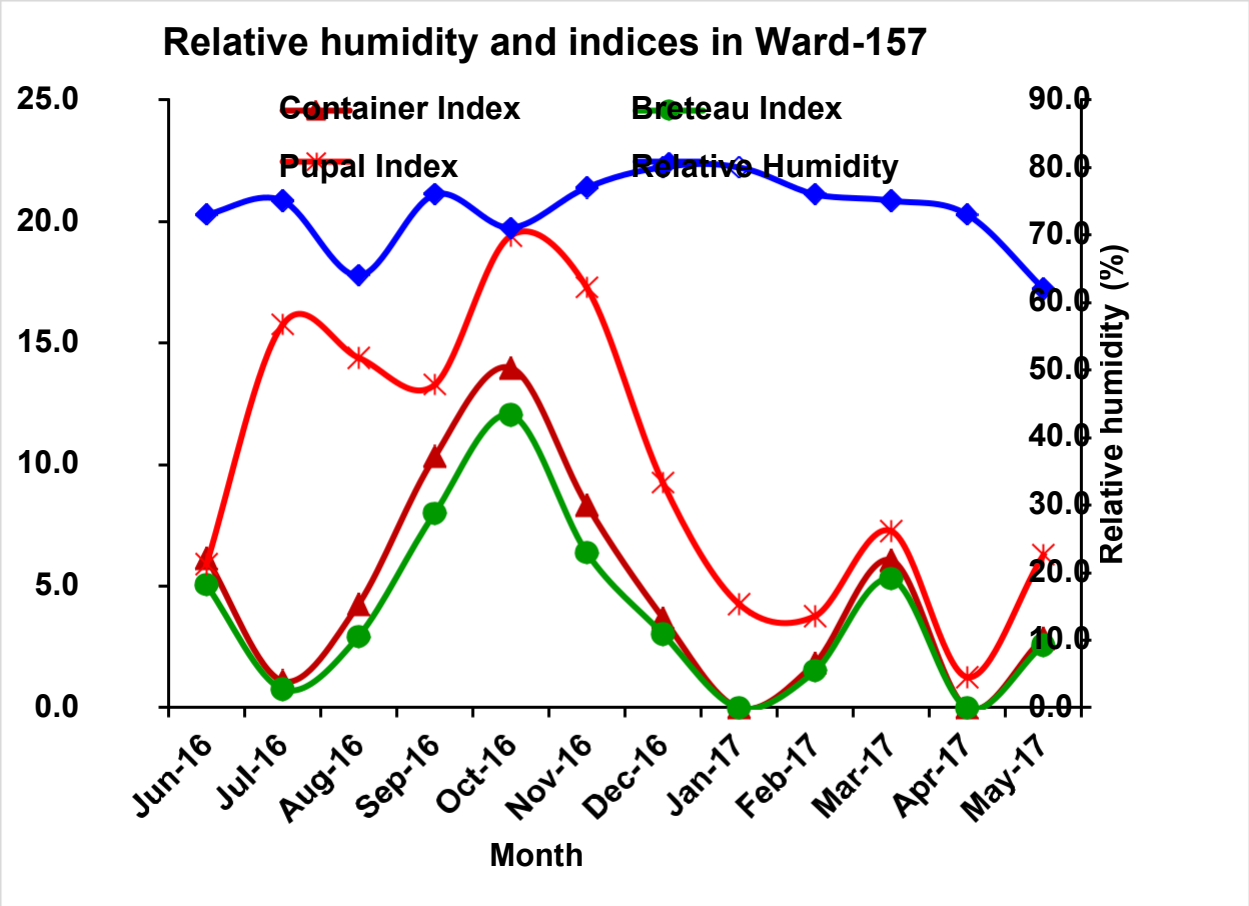

Temperature and indices in Ward-156
Container Index
Breteau Index
Pupal Index
Temperature
Index value
°Temperature(C)
25.0
20.0
15.0
10.0
5.0
0.0
40.0
35.0
30.0
25.0
20.0
15.0
10.0
5.0
0.0
Jun-16
Jul-16
Aug-16
Sep-16
Oct-16
Nov-16
Dec-16
Jan-17
Feb-17
Mar-17
Apr-17
May-17
Month

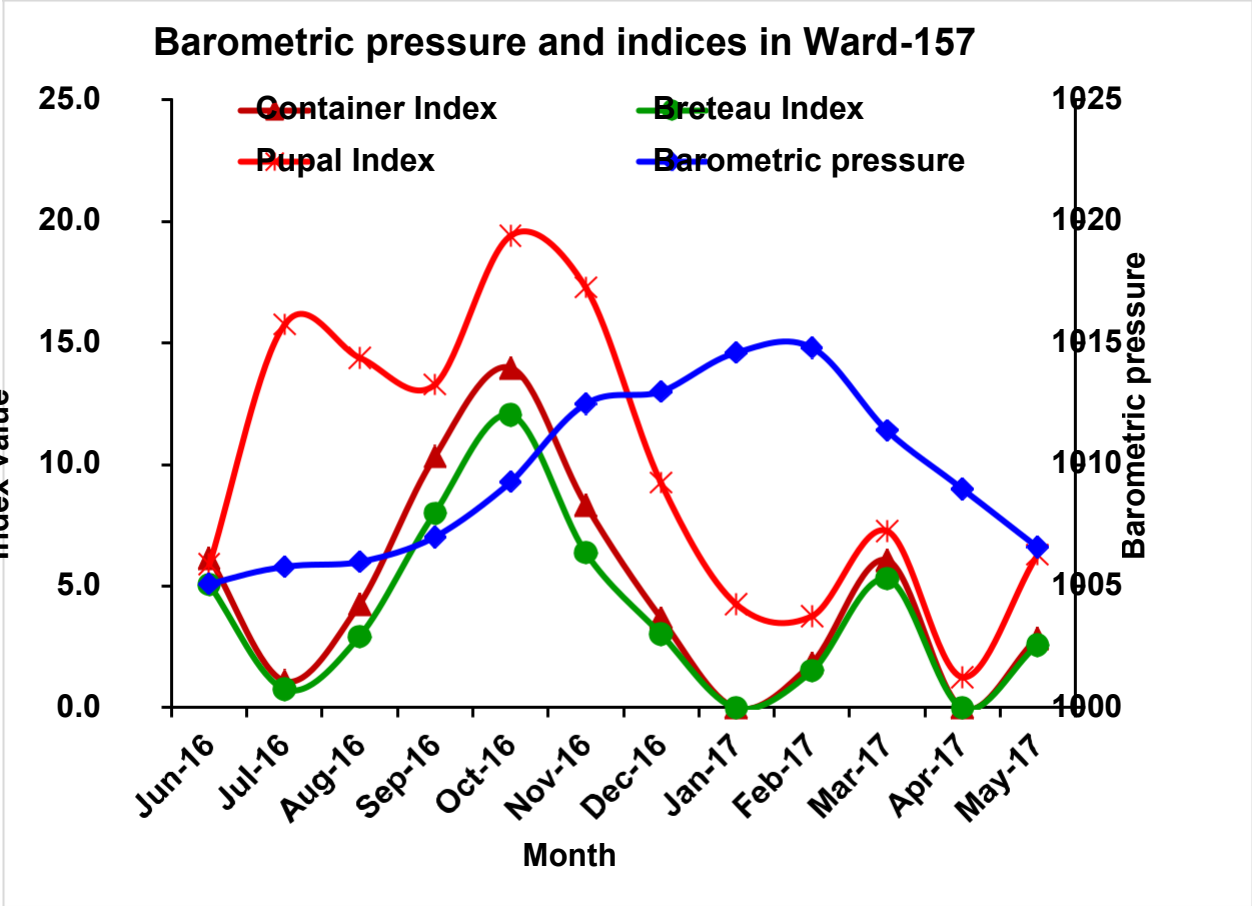

Relative humidity and indices in Ward-156
Container Index
Breteau Index
Pupal Index
Relative Humidity
Index value
Relative humidity (%)
Month
25.0
20.0
15.0
10.0
5.0
0.0
90.0
80.0
70.0
60.0
50.0
40.0
30.0
20.0
10.0
0.0
Jun-16
Jul-16
Aug-16
Sep-16
Oct-16
Nov-16
Dec-16
Jan-17
Feb-17
Mar-17
Apr-17
May-17

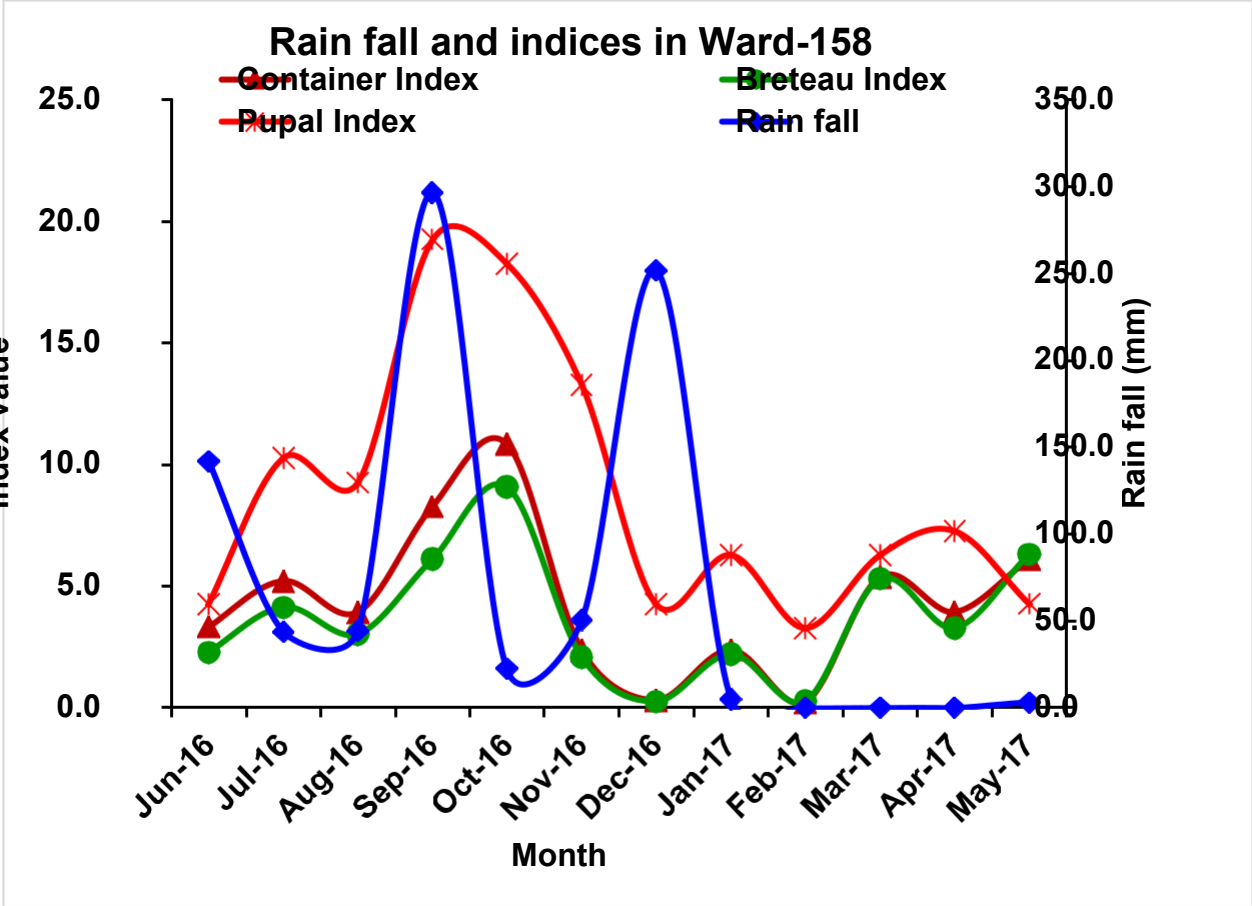

Barometric pressure and indices in Ward-156
Container Index
Breteau Index
Pupal Index
Barometric pressure
Index value
Barometric pressure
25.0
20.0
15.0
10.0
5.0
0.0
1025
1020
1015
1010
1005
1000
Jun-16
Jul-16
Aug-16
Sep-16
Oct-16
Nov-16
Dec-16
Jan-17
Feb-17
Mar-17
Apr-17
May-17
Month

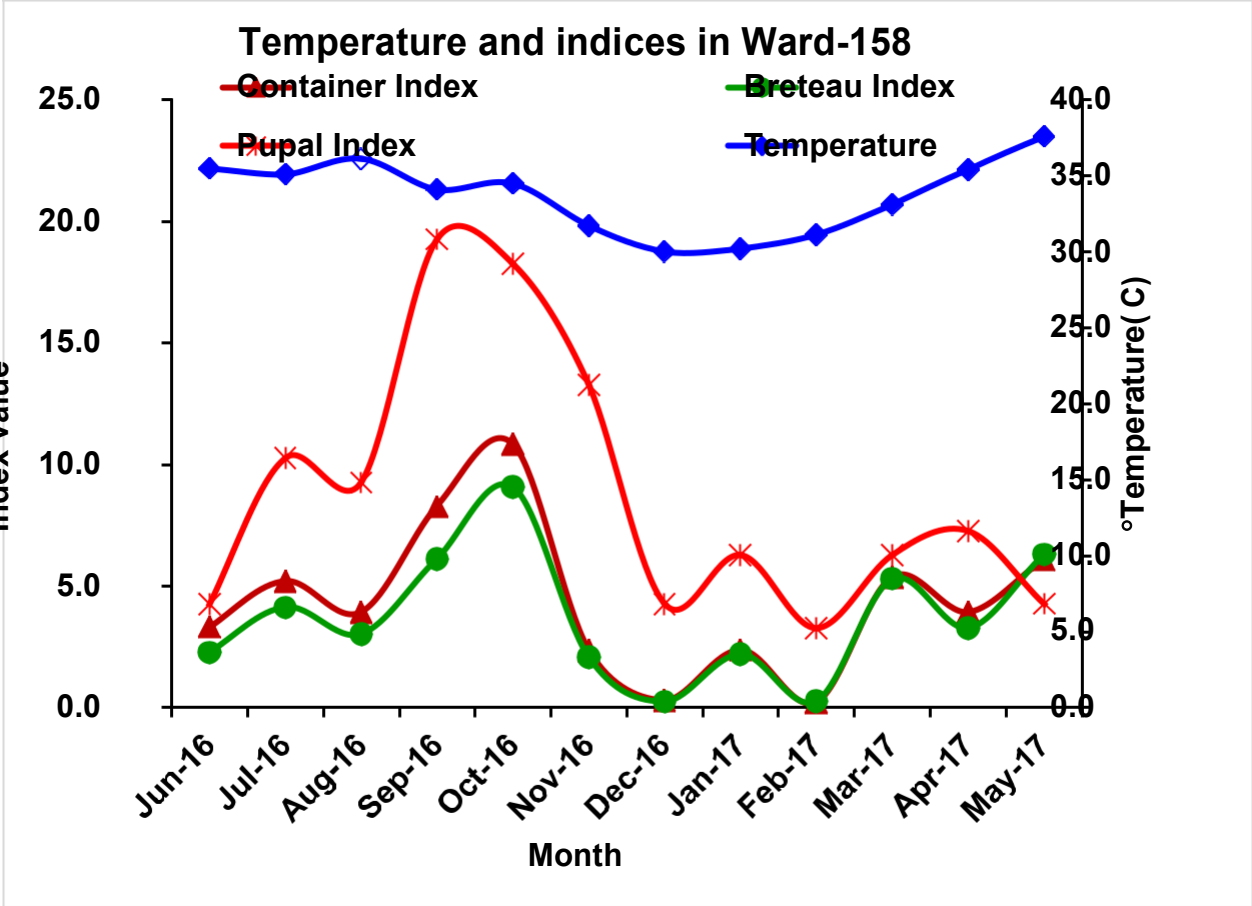

Rain fall and indices in Ward-157
Container Index
Breteau Index
Index value
Rain fall (mm)
Month
25.0
20.0
15.0
10.0
5.0
0.0
350.0
300.0
250.0
200.0
150.0
100.0
50.0
0.0
Jun-16
Jul-16
Aug-16
Sep-16
Oct-16
Nov-16
Dec-16
Jan-17
Feb-17
Mar-17
Apr-17
May-17

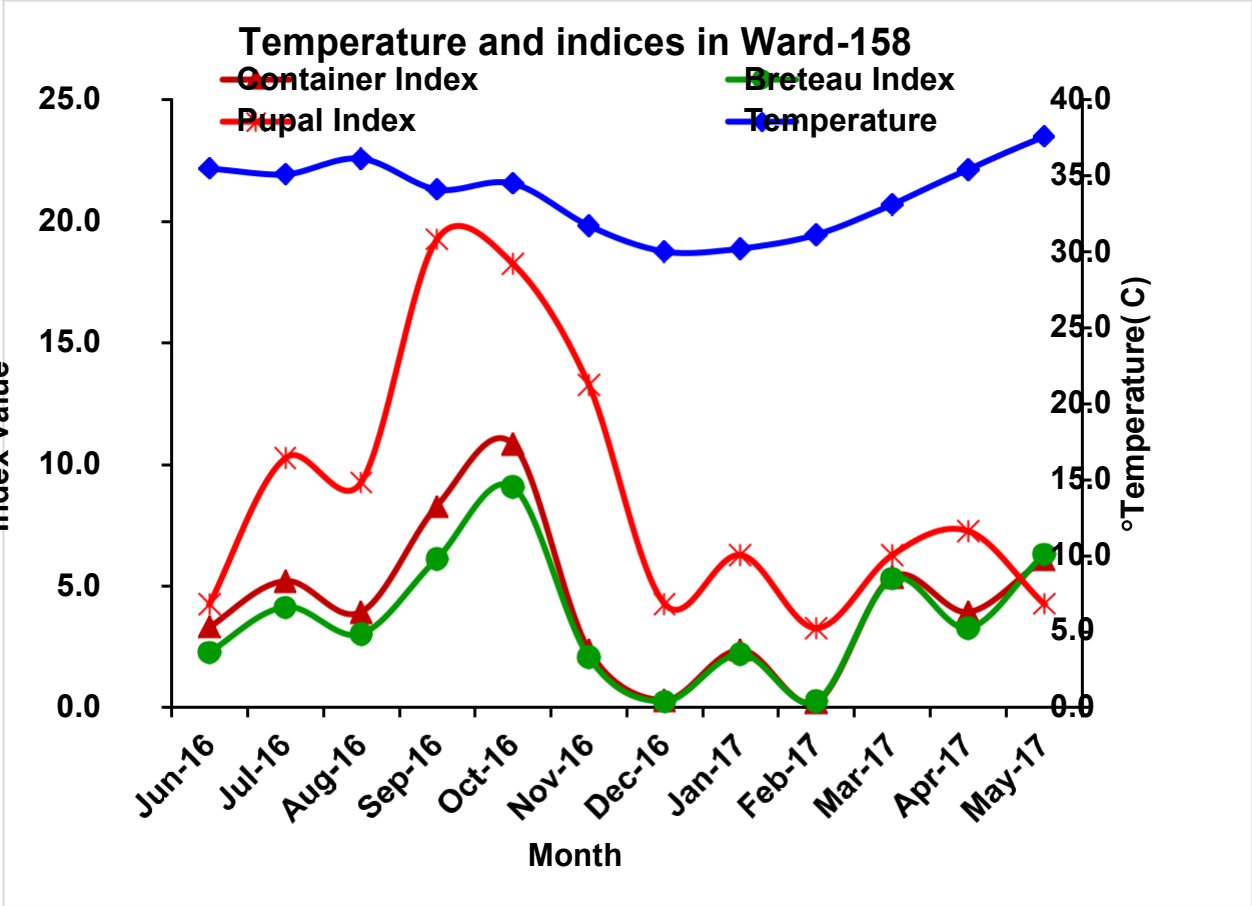

Temperature and indices in Ward-157
Container Index
Breteau Index
25.0
20.0
15.0
10.0
5.0
0.0
Index value
40.0
35.0
30.0
25.0
20.0
15.0
10.0
5.0
0.0
°Temperature(C)
Jun-16
Jul-16
Aug-16
Sep-16
Oct-16
Nov-16
Dec-16
Jan-17
Feb-17
Mar-17
Apr-17
May-17
Month

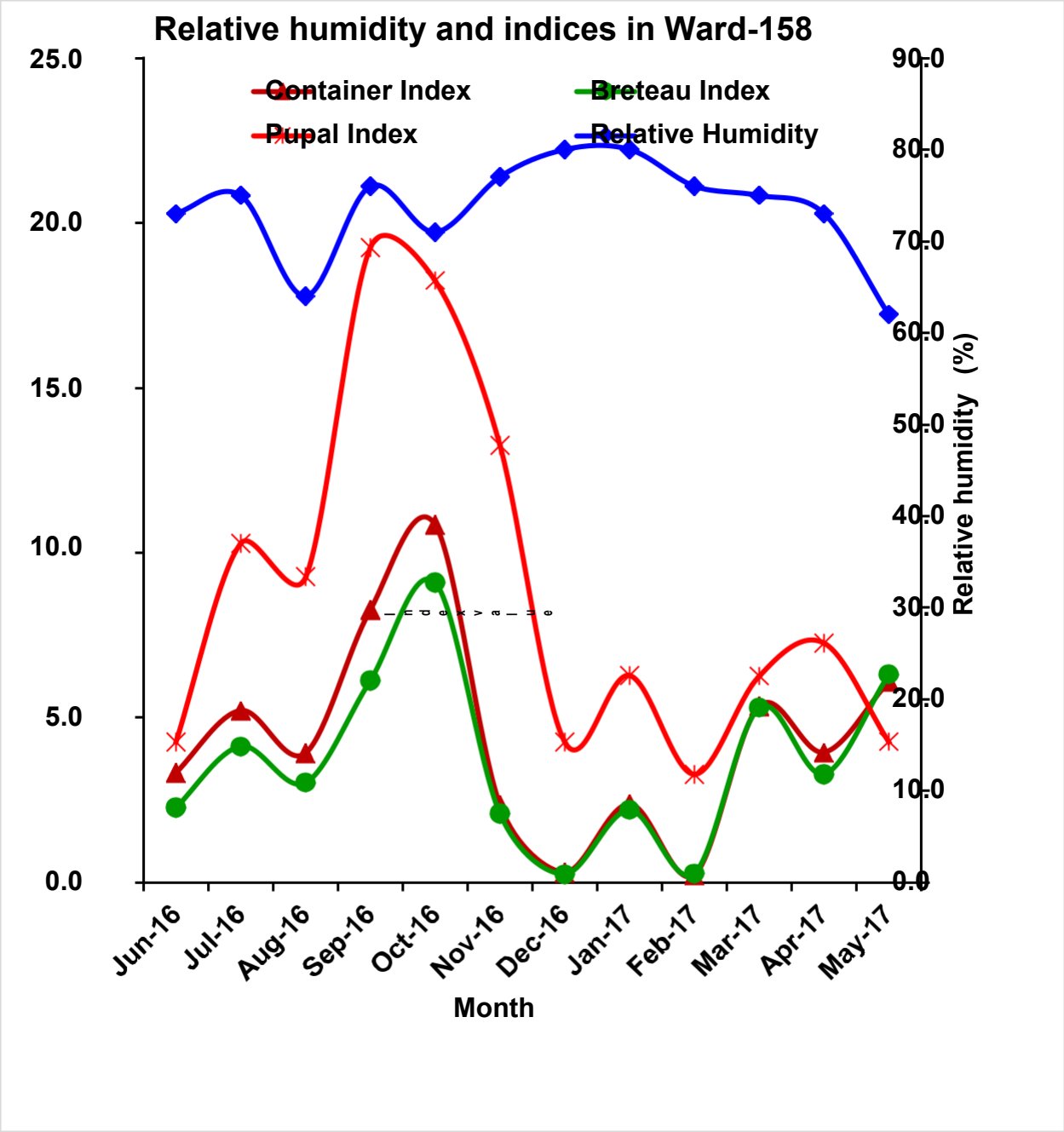

Relative humidity and indices in Ward-157
Container Index
Breteau Index
Pupal Index
Relative Humidity
Index value
Relative humidity (%)
Month
25.0
20.0
15.0
10.0
5.0
0.0
90.0
80.0
70.0
60.0
50.0
40.0
30.0
20.0
10.0
0.0
Jun-16
Jul-16
Aug-16
Sep-16
Oct-16
Nov-16
Dec-16
Jan-17
Feb-17
Mar-17
Apr-17
May-17

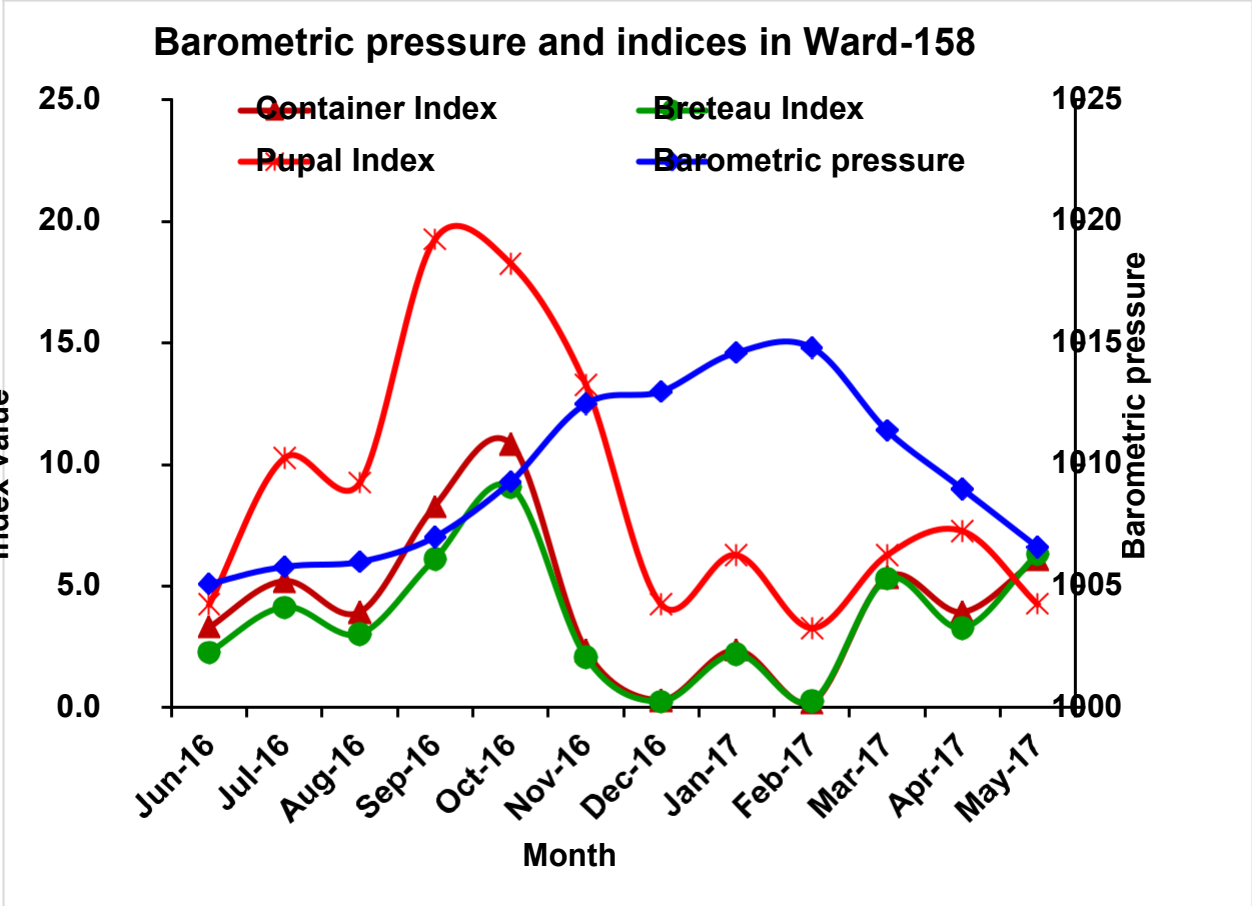

Barometric pressure and indices in Ward-157
Container Index
Breteau Index
Pupal Index
Barometric pressure
Index value
Barometric pressure
25.0
20.0
15.0
10.0
5.0
0.0
1025
1020
1015
1010
1005
1000
Jun-16
Jul-16
Aug-16
Sep-16
Oct-16
Nov-16
Dec-16
Jan-17
Feb-17
Mar-17
Apr-17
May-17
Month

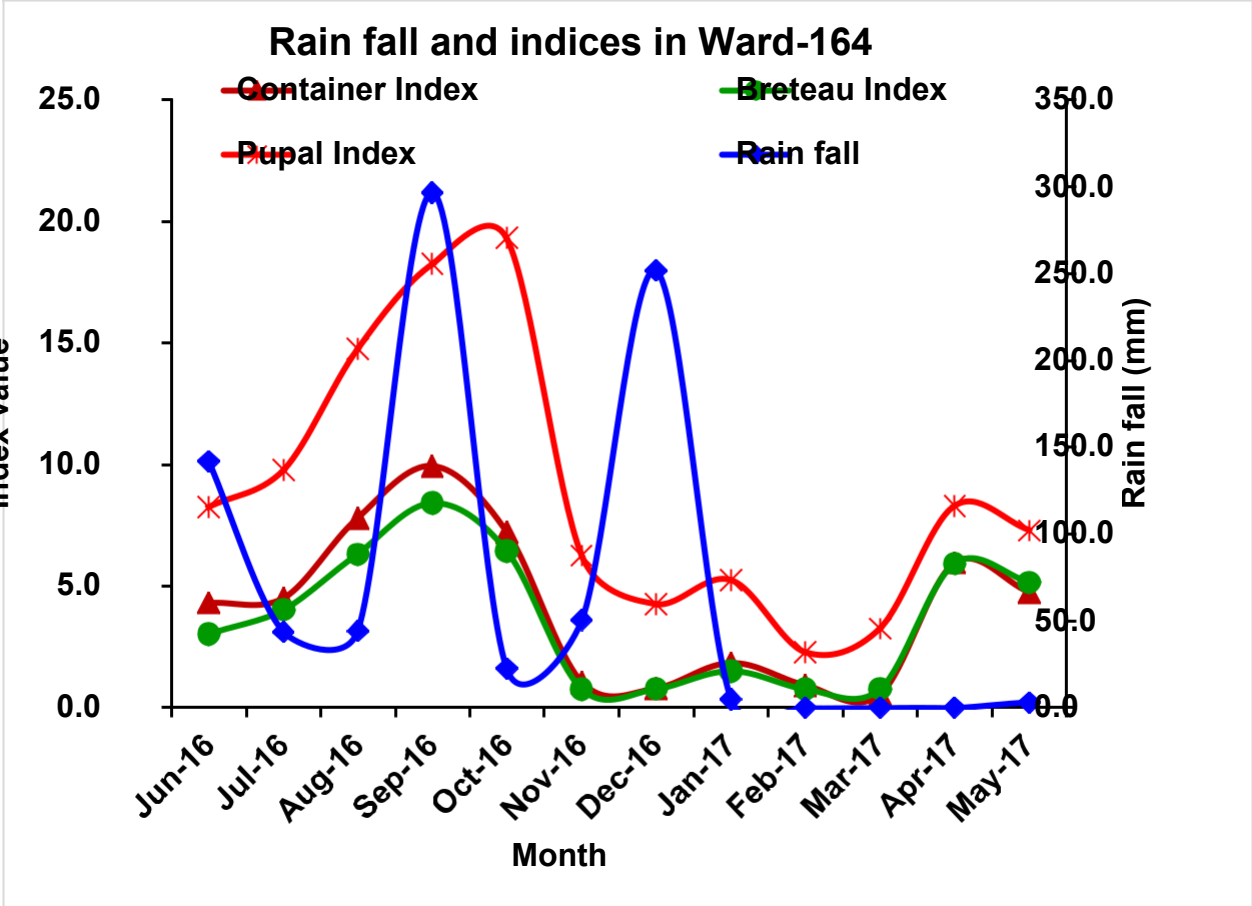

Rain fall and indices in Ward-158
Container Index
Breteau Index
Pupal Index
Rain fall
Index value
Rain fall (mm)
25.0
20.0
15.0
10.0
5.0
0.0
350.0
300.0
250.0
200.0
150.0
100.0
50.0
0.0
Jun-16
Jul-16
Aug-16
Sep-16
Oct-16
Nov-16
Dec-16
Jan-17
Feb-17
Mar-17
Apr-17
May-17
Month

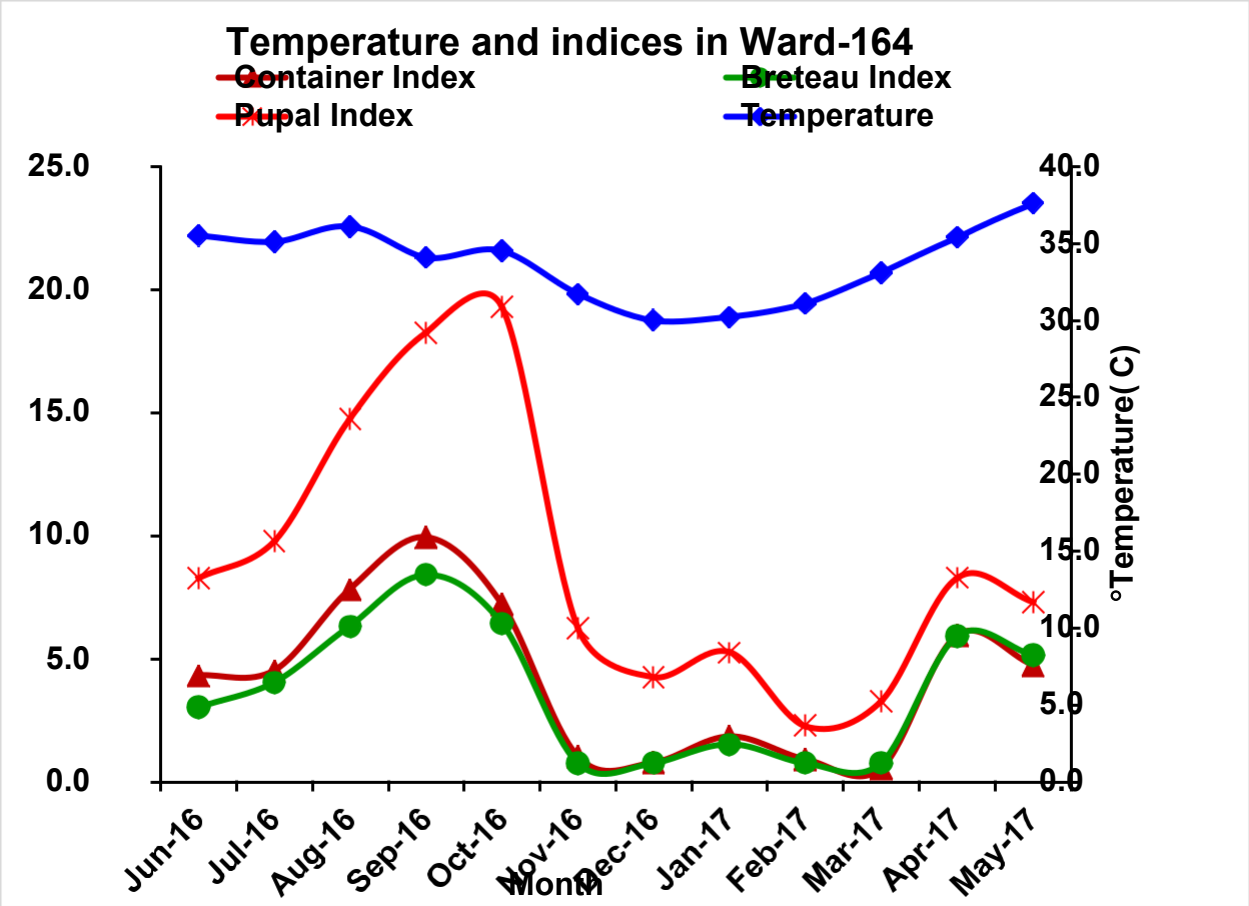

Temperature and indices in Ward-158
Container Index
Breteau Index
Pupal Index
Temperature
Index value
°Temperature(C)
Month
25.0
20.0
15.0
10.0
5.0
0.0
40.0
35.0
30.0
25.0
20.0
15.0
10.0
5.0
0.0
Jun-16
Jul-16
Aug-16
Sep-16
Oct-16
Nov-16
Dec-16
Jan-17
Feb-17
Mar-17
Apr-17
May-17

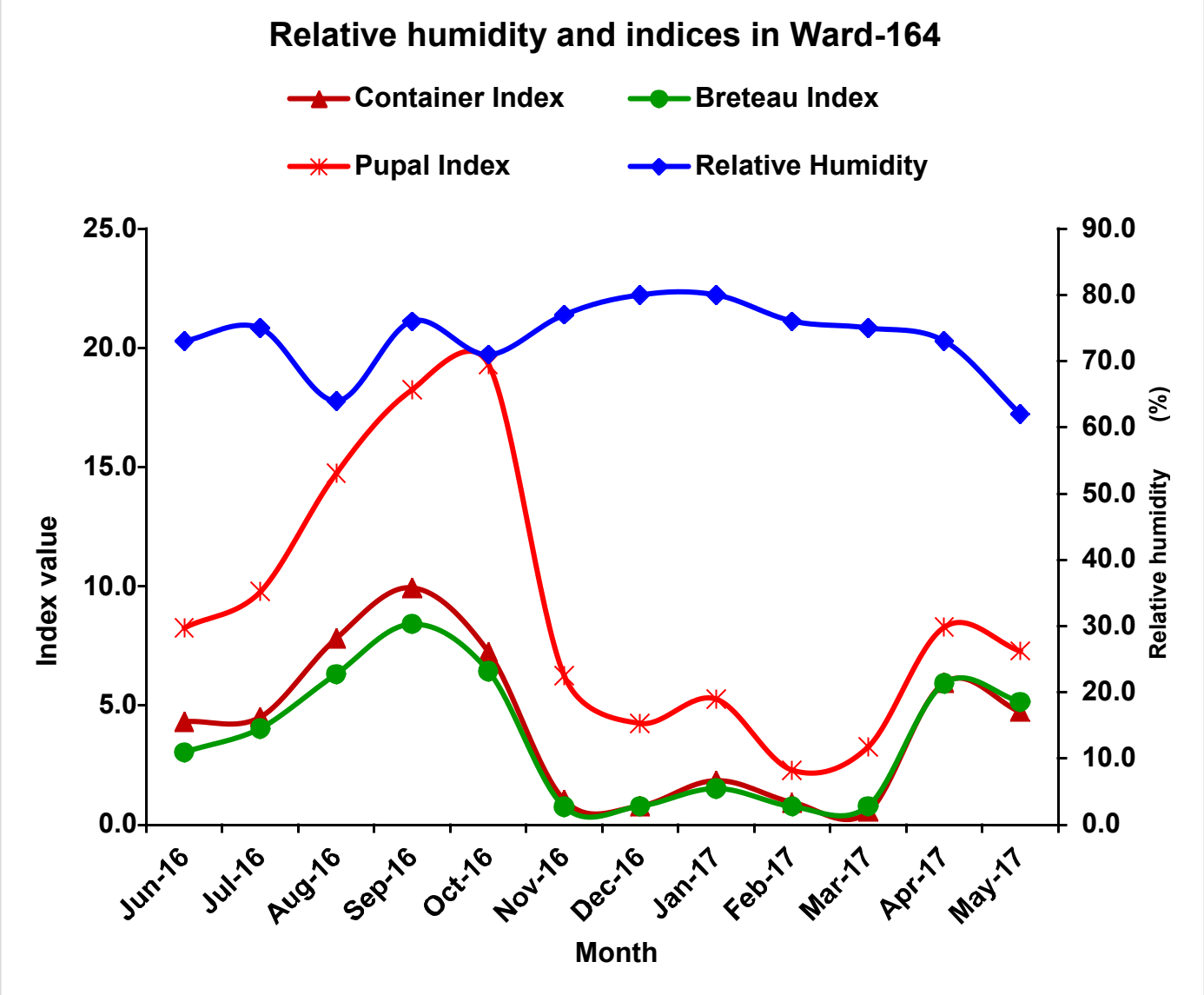

Temperature and indices in Ward-158
Container Index
Breteau Index
Pupal Index
Temperature
Index value
°Temperature(C)
Month
25.0
20.0
15.0
10.0
5.0
0.0
40.0
35.0
30.0
25.0
20.0
15.0
10.0
5.0
0.0
Jun-16
Jul-16
Aug-16
Sep-16
Oct-16
Nov-16
Dec-16
Jan-17
Feb-17
Mar-17
Apr-17
May-17

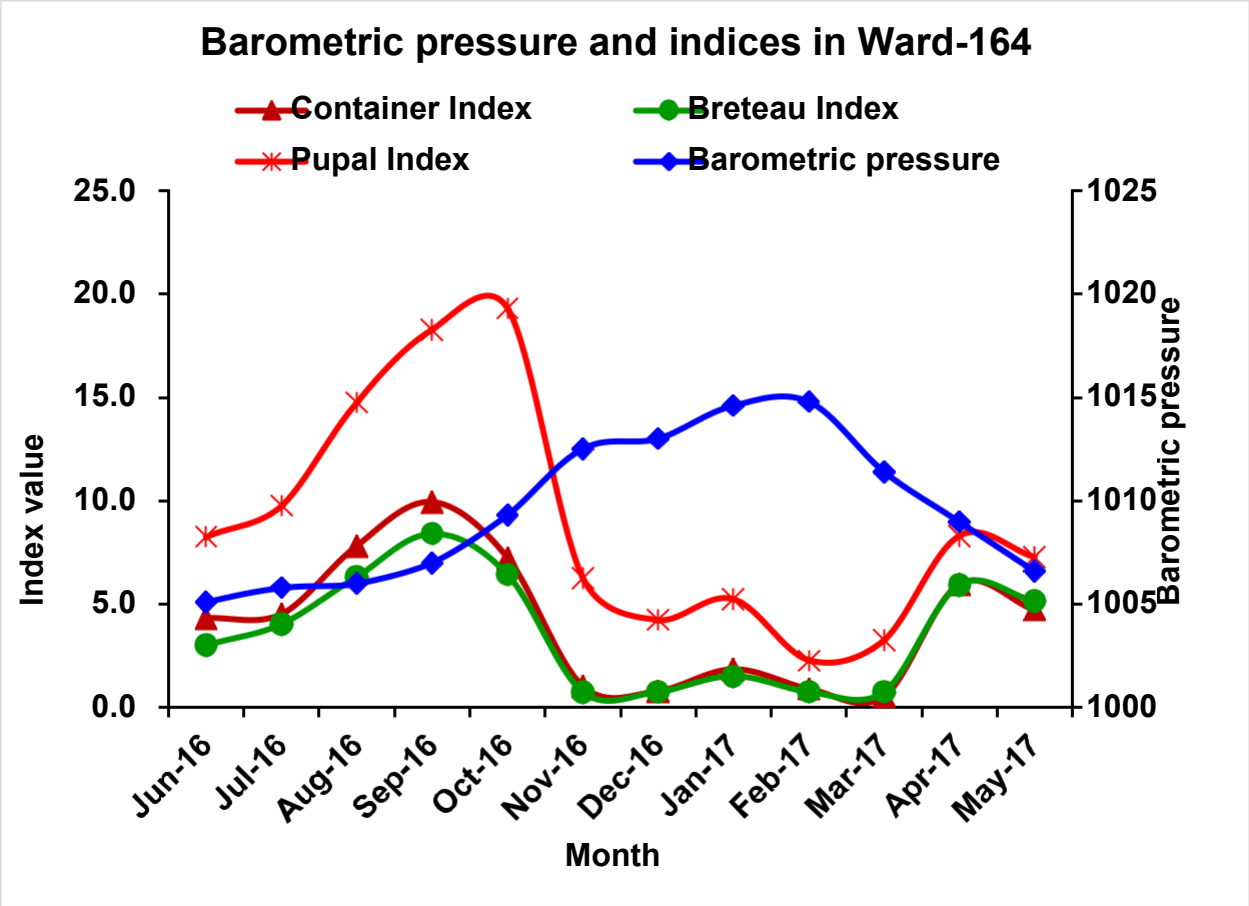

Relative humidity and indices in Ward-158
Container Index
Breteau Index
Pupal Index
Relative Humidity
25.0
20.0
15.0
10.0
5.0
0.0
90.0
80.0
70.0
60.0
50.0
40.0
30.0
20.0
10.0
0.0
Relative humidity (%)
Index value
Jun-16
Jul-16
Aug-16
Sep-16
Oct-16
Nov-16
Dec-16
Jan-17
Feb-17
Mar-17
Apr-17
May-17
Month


Barometric pressure and indices in Ward-158
Container Index
Breteau Index
Pupal Index
Barometric pressure
Index value
Barometric pressure
25.0
20.0
15.0
10.0
5.0
0.0
1025
1020
1015
1010
1005
1000
Jun-16
Jul-16
Aug-16
Sep-16
Oct-16
Nov-16
Dec-16
Jan-17
Feb-17
Mar-17
Apr-17
May-17
Month


Rain fall and indices in Ward-164
Container Index
Breteau Index
Pupal Index
Rain fall
Index value
Rain fall (mm)
25.0
20.0
15.0
10.0
5.0
0.0
350.0
300.0
250.0
200.0
150.0
100.0
50.0
0.0
Jun-16
Jul-16
Aug-16
Sep-16
Oct-16
Nov-16
Dec-16
Jan-17
Feb-17
Mar-17
Apr-17
May-17
Month


Temperature and indices in Ward-164
Container Index
Breteau Index
Pupal Index
Temperature
Index value
°Temperature(C)
Month
25.0
20.0
15.0
10.0
5.0
0.0
40.0
35.0
30.0
25.0
20.0
15.0
10.0
5.0
0.0
Jun-16
Jul-16
Aug-16
Sep-16
Oct-16
Nov-16
Dec-16
Jan-17
Feb-17
Mar-17
Apr-17
May-17


Relative humidity and indices in Ward-164
Container Index
Breteau Index
Pupal Index
Relative Humidity
Index value
Relative humidity (%)
Month
25.0
20.0
15.0
10.0
5.0
0.0
90.0
80.0
70.0
60.0
50.0
40.0
30.0
20.0
10.0
0.0
Jun-16
Jul-16
Aug-16
Sep-16
Oct-16
Nov-16
Dec-16
Jan-17
Feb-17
Mar-17
Apr-17
May-17



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