Original Research Paper

Effect of Rainfall on the Breeding of *Aedes Aegypti*, A Vector of Dengue/DHF and Chikunguniya with Respect to Container Positivity in Western Rajasthan

Medical Science

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ABSTRACT   *Entomological investigations have been carried-out to study the impact of rainfall on the container positivity for Aedes aegypti breeding in Jodhpur, which represent a western arid part of Rajasthan state. The month-wise data of container positivity in relation to rainfall was observed directly proportionate (R=0.88, 76.8% correlation). Similarly, the data of prevalence of fourth instar larvae (L-4) & PDI exhibited a positive trend in relation to rainfall (R=0.88, R=0.72). The association of positivity of individual container with the rainfall revealed that Underground Cemented tanks, Ground Cemented tanks, Ground plastic drums, Clay/Pitchers and Coolers has positive correlation (R=0.79, R=0.85, R=0.88, R=0.76, R=0.87), whereas, Overhead Cemented tanks exhibited negative correlation (R= -0.76), however, the positivity of Overhead Syntex Plastic tanks, Ground Plastic Tanks, Ground Plastic tubs, Ground Metallic pots and Bird pots did not exhibit any correlation. The rainfall also exhibited strong positive association with different entomological parameters i.e. CI, BI, LDI and PDI (R=0.88, R=0.88, R=0.87, R=0.72). The study reveals that correlations of rainfall with container positivity and entomological indices during different monsoon months, can be exploited for targeting the respective containers while undertaking intervention measures against Ae. aegypti mosquitoes in a focussed manner.*

INTRODUCTION

Mosquitoes and other poikilothermic vector organisms are sensitive to climatic factors such as temperature, precipitation, and humidity. The *Aedes aegypti* mosquito, the principal vector for dengue/DHF, is particularly susceptible to climate variability and climatic change. Indeed, *Ae. aegypti* is a domestic mosquito, which lays eggs preferentially in domestic as well as artificial containers left indoors and outdoors by people. These include a variety of domestic containers with a majority of discarded receptacles, but also water storage containers, tires, wells, cement tanks and sinks (Kusumawathie, 2005; Kumawat & Singh, 2016). In Indian subcontinents *Ae. aegypti* is an urban vector and its populations fluctuate with rainfall and water storage habitats (Kalra *et al*., 1968).

Preventive measures for Dengue/DHF rely entirely on vector control, the most effective method for reducing disease transmission in urban & semi-urban areas of the world (Reiter & Gubler, 1997). It is therefore important to perform new studies and use the findings to formulate disease prevention and control strategies and plans. Hence, the present studies have been carried-out to determine the impact of Rainfall on the breeding behaviour of *Aedes aegypti* in urban arid situations and to identify productive breeding sites and key containers of *Aedes aegypti* during monsoon months.

METHODOLOGY

The entomological data was collected from Bamba Mohalla of Jodhpur city during the monsoon months i.e. May, June, July & August. The breeding sites of *Ae. aegypti* were detected in the domestic conditions located both inside and outside the houses. Each container was examined for the presence of eggs, larvae and pupae and their number per container was recorded. All the larvae and pupae collected were reared into adults for their identification. Different types of water containers placed at different locations in the Household, were identified as Underground Cemented Tanks, Overhead Syntex Plastic Tanks, Ground Cemented Tanks, Overhead Cemented Tanks, Ground Plastic Tanks, Ground Plastic Drums, Clay Pitchers, Metallic Pots, Coolers and Cow Pots, Bird pots and Iron tanks.

Daily meteorological data for the period January 2007-December 2010 was obtained from the surface annual climato-logically report of the Central Arid Zone Research Institute (CAZRI, ICAR), Jodhpur. Data on ambient Rainfall was expressed in millimeter (mm).

The larval indexes of various months of the study were recorded and analysed. The relative prevalence indices of *Ae. aegypti* used were Breteau Index (BI), Larval Density index (LDI), Container index (CI) and the Pupal Density Index (PDI). These indices are required for determining the spatial and temporal distribution of *Ae. aegypti* in the study areas and are considered to be most informative measure for surveillance of dengue vector. Correlation test (R) was performed between various entomological indices such as CI, BI, LDI, PDI etc. with rainfall month-wise to analyze any significant correlation occur between them or not. Similarly month-wise correlation test was performed between individual container positivity and the rainfall.

RESULTS

During the study 10 types of indoor containers and 07 types of outdoor containers were recorded. In all 1146 containers were examined out of which 2.3% containers were found positive for different immature stages of *Ae. aegypti* (Table 1). A total of 445 larvae and 49 pupae were collected from the positive containers. Highest number of larvae and pupae (9.5 & 0.8%) were collected during the month of August (Table 2). An increasing trend of rainfall was observed from May to June, which decreased from June to July and again increased from July to August. The month-wise data of container positivity in relation to rainfall was observed directly proportionate (R=0.88) and with highest 76.8% correlated. Similarly, the data of prevalence of fourth instar larvae (L-4) and PDI exhibited a positive trend in relation to rainfall (R=0.88, R=0.68).

Table-1: Month-wise entomological indices and rainfall in the study area.

Different Parameters	Study-Months			
	May	June	July	August
Rainfall (mm)	45.4	133.9	120.7	202.9
Container Index	0.8	2.6	0.8	4.5
Breteau Index	0.02	0.08	0.02	0.14
Larval Density Index	1.0	3.3	1.0	9.5
Pupal Density Index	0.3	0.2	0.3	0.8

The Container Index was observed increased from May to June but decreases from June to July and again increases from July to August. The BI was observed decreased during May and June but increased from June to August. The LDI was observed increased from May to June but decreased from June to July and again increased in the month of August. The PDI was found increased from May to June but decreased from June to August. Highest CI, BI and LDI were observed in August while highest PDI was observed in June (Table 1). The association of rain-fall was also observed with different entomological parameters i.e. CI, BI, LDI and PDI. The data exhibited that CI, BI, LDI & PDI all has strong positive association with relative humidity (R=0.88, R=0.88, R=0.87, R=0.72).

The monthly container positivity data of each container was correlated with the rainfall data of of the study months. The analysis revealed that positivity of Underground Cement tanks, Ground Cemented tanks, Ground Plastic drum, Clay and Coolers has positive correlation (R=0.79, R=0.85, R= 0.87, R= 0.76, R=0.87) with rainfall, whereas, Overhead Cemented tanks exhibited negative correlation (R= -0.76), but the positivity of Overhead Syntex Plastic tanks, Ground Plastic tubs, Ground Metallic pots and Bird pots did not exhibited any correlation (Table 2).

Table-2: Month-wise data on positive containers and average rainfall in the study area.

Type of containers	Month-wise details of rain-fall and container positivity															
	May (Rainfall-45.4)				June (Rainfall-133.9)				July (Rainfall-120.7)				August (Rainfall-202.9)			
	TC*	P	L4	TP	TC	P	L4	TP	TC	P	L-4	TP	TC	P	L-4	TP
Underground Cemented Tank (Tanka)	3	0	0	0	5	0	0	0	3	0	0	0	5	1	5	2
Overhead Syntex Plastic Tanks	4	0	0	0	13	0	0	0	6	0	0	0	13	0	0	0
Ground Plastic Tanks	0	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0
Ground Cement Tanks	23	0	0	0	20	2	5	2	25	0	0	0	20	4	35	10
Overhead Cement Tanks	6	1	5	5	2	0	0	0	6	1	5	5	2	0	0	0
Ground Plastic Drum	6	1	10	5	33	2	11	2	6	1	10	5	33	3	30	7
Ground Plastic Tubs	78	0	0	0	77	0	0	0	77	0	0	0	77	0	0	0
Clay Pitchers	96	0	0	0	110	1	4	0	94	0	0	0	110	1	5	0
Ground Metallic Pots	29	0	0	0	26	0	0	0	31	0	0	0	26	0	0	0
Coolers	14	0	0	0	23	3	8	2	14	0	0	0	23	6	27	4
Cow Pots	3	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0
Bird Pots	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Iron Tanks	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	262	2	15	10	311	8	28	6	262	2	15	10	311	14	102	23

*TC=Total Containers Examined, P=Total Positive Containers, **L4**=Total L-4 Larve found, **TP**=Total Pupae

Table 3 indicates that the data of prevalence of fourth instar larvae (L-4) was found highly correlated with rainfall in case of Coolers (75.9%, R= 0.87), followed by Ground Cement tanks, Clay/pitchers, Ground Plastic drums and Underground Cement tanks (70.7% & R=0.84; 67.5% & R=0.82; 66.2% & R=0.81; 63.5% & R=0.79). While the data of prevalence of pupae (PDI) was found highly correlated with rainfall in case of Coolers (76.8%, R=0.87), followed by Ground Cement tanks and Underground Cement tanks (73.1% & R=0.85; 63.5% & R=0.79).

Table 3: Month-wise records of Rainfall and Entomological indices of individual positive containers

Type of Containers	Month-wise details of rain-fall and Entomological Indices											
	May (Rainfall-45.4) (BI=0.02)			June (Rainfall-133.9) (BI=0.08)			July (Rainfall-120.7) (BI=0.02)			August (Rainfall-202.9) (BI=0.14)		
	CI	LDI	PDI	CI	LDI	PDI	CI	LDI	PDI	CI	LDI	PDI
Underground Cemented Tank (Tanka)	00	00	00	00	00	00	00	00	00	20.0	0.17	0.07
Ground Cement Tanks	00	00	00	10.0	0.7	0.07	00	00	00	20.0	3.0	0.3
Overhead Cement Tanks	16.7	0.3	0.17	00	00	00	16.7	0.3	0.17	00	00	00
Ground Plastic Drum	16.7	0.7	0.17	6.1	1.7	0.07	16.7	0.7	0.17	9.1	3.7	0.23
Ground Plastic Tubs	00	00	00	00	00	00	00	00	00	00	00	00
Clay Pitchers	00	00	00	0.9	0.3	00	00	00	00	0.9	0.83	00
Ground Metallic Pots	00	00	00	00	00	00	00	00	00	00	00	00
Coolers	00	00	00	13	0.7	0.07	00	00	00	26.1	1.83	0.13
Total	0.76	1.0	0.3	8.0	3.3	0.2	0.76	1.0	0.3	4.5	9.5	0.77

DISCUSSION

The effect of rainfall is more complex. Rainfall events can increase mosquito abundance by increasing the availability of mosquito juvenile habitat (e.g., containers in the patio with standing water). However, heavy rainfall events can decrease mosquito abundance by flushing larvae from containers. Rainfall as an early indicator of vector reproduction has obvious advantages over late indicators, such as ovit-rap indices, larval density, *Aedes* house indices and Breteau indices (Foo *et al*, 1985). Moore (1978) in Puerto Rico used temporal graphics to compare the seasonal fluctuation of rainfall, *Aedes* larval indices and dengue incidence.

Lim *et al*, 2013 during study sites at Malaysia, also found rainfall as an important environmental factor associated with *Aedes* breeding. Micieli and Campos (2003) also observed the close relation of the highest peak of *Aedes aegypti* population with high rainfall, and the population decreased for the months with less rainfall which is conformity of our observations. Favier *et al.* (2006), studying the relationship between climate and *Ae. aegypti* in an area of Brasília, Brazil, found an association between the Container Index and relative humidity, the number of water-holding containers and rainfall and the mean number of pupae per positive container and mean temperature.

In India Dengue infections generally occur during or after rain along with the rise in the vector *Ae. aegypti* population. Katyal *et. al*, 1995 in Delhi found out that the primary breeding sources for *Ae. aegypti* during pre-monsoon season were cement tanks and non- removable clay jars while with onset of monsoon season discarded tyres and desert coolers as secondary breeding sources. Frietas *et al*, 2007 while studying seasonal variation in container productivity and infestation levels by *Aedes aegypti* in Rio de Janerio, Brazil found the water tanks and metal drums as most productive containers for breeding large amount of pupae in both dry and rainy seasons. Aziz *et al.*, 2012 in Saudi Arabia located indoor and permanent containers for breeding of *Aedes* mosquitoes and also found that *Ae. aegypti* larval indices recorded were greater during rainy season

The finding clearly indicate that container positivity and entomological indices have definite strong correlations with rainfall and the information so gathered can be utilized for targeting the respective containers while undertaking control measures against *Ae. aegypti* mosquitoes.

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