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SUSTAINABLE ENVIRONMENTAL SANITATION AND WATER SERVICES

DRWH Systems and Mosquito Breeding and its Control

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Introduction :

Anopheles stephensi and *Aedes aegypti* (both container breeders) are the major insect species, which need to be considered in the context of DRWH, especially in the humid tropics. The present paper hence deals essentially with breeding of mosquitoes, with focus on these species and their control. Designing for mosquito control requires an understanding of breeding habits, life cycle and behavioral patterns of the insects as well as the mode of disease transmission. Preventive measures have thus to be taken to minimize the risk. It must be noted that firstly the availability of water in the vicinity is an important prerequisite for mosquito breeding. Denying access to water is universally effective in controlling the breeding. Preventing stagnation of water on the gutter, area around DRWH site and also use of barriers for barring the entry of the adult would be excellent, but is not always feasible. In such case appropriate measures for deterring the egg laying and their subsequent growth has to be looked into. Accordingly, the following issues, which would be useful from the point of view of DRWH design, were examined :

- Barriers for preventing the approach of adult mosquitoes to different parts of DRWH.
- Quality of water and other parameters, which discourage or encourage ovi-position and larval growth.

Barriers for preventing approach of adult mosquitoes to different parts of DRWH :

Three types of barries may be envisaged to prevent entry of mosquitoes

1. Have repellents in the surrounding areas so that mosquitoes are deterred from entering DRWH sites. Burning of leaves, wood smoke and other repellents (e.g. mint, *Vitex negundo* & other essential oils) may be useful.
2. Have traps with suitable attractant so that the mosquito reaching the site gets attracted and enters the trap (use of CO_2 trap & other attractants. Availability and cost economics would however be an issue)
3. Have physical barriers such as sealing/ screens, which will physically prevent entry of mosquito and larvae into the DRWH system.

Sealing

Though it is not possible to seal DRWH tanks and to maintain that seal. However tight covers could be used for ferrocement tanks. Polythene could also be used for this.

Screens

Beyond doubt the screens are useful in preventing the entry of adult mosquitoes, which range 5-12 mm in size. However, the effectiveness of different mesh sizes are to be seen not only with respect to screening adult mosquitoes but also larvae and eggs, the size of which may range from < 1 mm to 6 mm as the eggs hatched and larvae develop through four stages.. In *Culex*, where eggs come in rafts, the overall size is higher although the individual eggs are small. Besides the size of eggs, the stretchability of mesh and speed with which water flows pushing the screen, are factors, which can affect the entry of larvae and eggs.

Quality of water and other parameters, which discourage or encourage ovi position and larval growth: Quality of water in terms of oxygen availability, nutrient status and temperature

Extensive studies on the breeding of mosquitoes in water samples with differnet levels of salts and dissolved oxygen have been conducted by the Malaria Research Centre in India (Table 1). It is clear from this that average dissolved oxygen requirement for *Culex*, *Aedes* and *Anopheles* are respectively 2.1, 6.2 and 6 ppm. It has also been quoted by others that mosquito larvae can grow at 4 ppm dissolved oxygen or even less. Generally, rainwater has sufficient dissolved oxygen at the time of its harvest as well as storage. Hence oxygen levels are not likely to deter ovi position in rainwater. As for nutrients, high levels of nutrients may not be needed intially. However, this would be an issue for larval growth. It is known that *Anopheles* and *Aedes* prefer clean water while *Culex* breed in water of higher BOD.

Table 1 : Chemical analysis of waters wupporting breeding of different species of mosquitoes

Mosquito		pH	Sodium	Chioride	Potassium	Bromide	Nitrates	Nitrites	Free ammonia	Dissolved oxygen
Anopheles	Range	7.97-9.525	60-2500	25-1760	7.8-175	0.27-8.22	3.8-13.3	1.4-43.8	1.2-6.6	4-10.6
	Average	(8.6)	(766)	(606.8)	(63.9)	(3.13)	(8.2)	(8.52)	(2.81)	(6.66)
Culex	Range	7.63-8.7	28-490	23.5-545	10-109	0.26-5.03	4.2-8.2	1.57-8.2	0.7-21.5	0.6-5.1
	Average	(8.1)	(256)	(236)	(35)	(1.79)	(5.4)	(3.8)	(6.99)	(2.1)
Aedes	Range	8.1-8.5	17-105	22.5-52	4.25-5.3	0.15-0.8	3.9-7.3	0.7-3.44	0.22-0.7	4.7-7.4
	Average	(8.26)	(52)	(36.3)	(4.75)	(0.4)	(5.3)	(1.94)	(0.45)	(6.2)
Mixed (Anopheles + Culex)	Range	7.9-10.8	45-910	65.7-961	7.3-67.8	0.76-4.73	3.01-10	0.7-27.50	1.1-16.8	1.0-10.2
	Average	(8.9)	(446)	(446.5)	(23.0)	(2.36)	(6.55)	(5.7)	(4.301)	(5.25)

Table 2 : Effect of water quality on growth of Anopheles stephensi first instar larvae

Date	Double distilled water						Tap water						Tap water + food (yeast powder + dog biscuits)						Rain water					
	I	II	III	IV	P	A	I	II	III	IV	P	A	I	II	III	IV	P	A	I	II	III	IV	P	A
07.02.2001	23	2					20	5					22	3					20	5				
08.02.2001	13	11																						
09.02.2001	5	18					7	16					2	21					9	16				
10.02.2001							9	9	5															
12.02.2001		20						18	5					1	2	21				13	8			
13.02.2001		10	8					17	6						2	21	2			8	13			
15.02.2001		1	17					3	4						2	17	5	2		4	13			
16.02.2001		1	17					3	4						2	10	8	4		2	11			
19.02.2001		3	3					3	3						1	8	2	13	2	8				
20.02.2001		1	5					3	3						1	7	1	14	1	9				
22.02.2001		5						1	3							7				2	5	2		

I – IV : instar larvae
P : Pupae
A : Adults

Note : 25 first instar larvae were placed in 200 ml water samples in a plastic bowl and the larval growth was observed as a function of time. Experiment was initated on 5.2.2001.

Results of experiments on ovi position and larval growth using rainwater samples were compared with these in tap water and double distilled water (Table 2). Ovi-position in rainwater and tap water was of similar order though in case of freshly doubled distilled water ovi position was relatively less. It was also seen that tap water, rain water and double distilled water supported larval growth up to third instar. In the case of doubel distilled water and tap water there was no fourth instar larvae and in rain water a few larvae could develop into fourth instar. However, in none of these cases there was emergence of adults indicating that nutrient availability could be the limiting factor.

Also, in case of solar radiation heats up the storage, there is a possibility that larvae may die if temperatures go beyond "thermal tolerance" limits. For example for *Anopheles minimus,* the thermal death point (TDP) is 41 degree C and for *Anopheles Vagus* it is 44 degree C.

Conclusions and Recommendations

Clean water is the basic requirement for these two species (*Anopheles stephensi* and *Aedes aegypti*). While, there is no direct epidemiological evidence of linking rainwater harvesting and mosquito as vectors for various diseases, if mosquitoes are already prevalent around and in the vicinity, a DRWH system would increase the probability of mosquito borne diseases in that area. Mosquito control measures have to be applied at all stages of the mosquito life cycle, with suitable ovicidal, larvicidal and adulticidal interventions. The preventive measures with regard to DRWH may be divided into three groups:

I) **Prevention of mosquito breeding in the surroundings.**

- Appropriate physical, chemical and biological means of control can be used.
- Different approaches to repel mosquitoes from the DRWH site may be undertaken.
- If there are depressions in the surrounding B.S., BTI, larvivorous fishes, aquatic plants, plant extracts, kerosene oil etc can be used as larvicides. Some of the well-tested chemicals may also be used.
- Personal protection may be taken to avoid mosquito bites.

II) **Prevention of mosquito breeding in the DRWH system.**

- Avoid all factors, which result in attracting mosquitoes.
- Tightly closed lids may be provided to the water storage system, so that there are no openings for the entry of mosquitoes.
- Screen may be used (with hole size less than 1 mm)to bar entry of mosquito larvae.
- Filter should be disinfected (eg. with household bleach)
- No stagnating water should be allowed around the DRWH site.
- Gutter leading to the storage should have a free flow of water.

III) **If inspite fo the above, eggs or larvae have entered DRWH, various ovicidal and larvicidal measures have to be considered.**

- The measures practiced for killing bacteria may also eliminate mosquito eggs and larvae. These include high temperature, boiling and use of botanicals.
- Addition of BTi/BS and other acceptable larvicides in water could be considered.
- Stored water in DRWH can be a potential breeding site for *Aedes* and *Anopheles*. The amounts of oxygen, light as well as nutrients in rainwater are sufficient for ovi position and larval growth. However nutrient availability will be the limiting factor for adult emergence.
- First flush deveice and use of screen between first flush system and storage could be tried as a barrier for preventing entry of adult mosquitoes as well 500 holes or more per square inch may be used to prevent entry of larvae and eggs. This can also filter of dust. However, the design of screen must allow for water flow during peak rain an periodic cleaning.
- Nylon mesh or cloth with 500 holes or more per square inch may be used to prevent entry of larvae and eggs. This can also filter of dust. However, the design of screen must allow for water flow during peak rain and periodic cleaning.