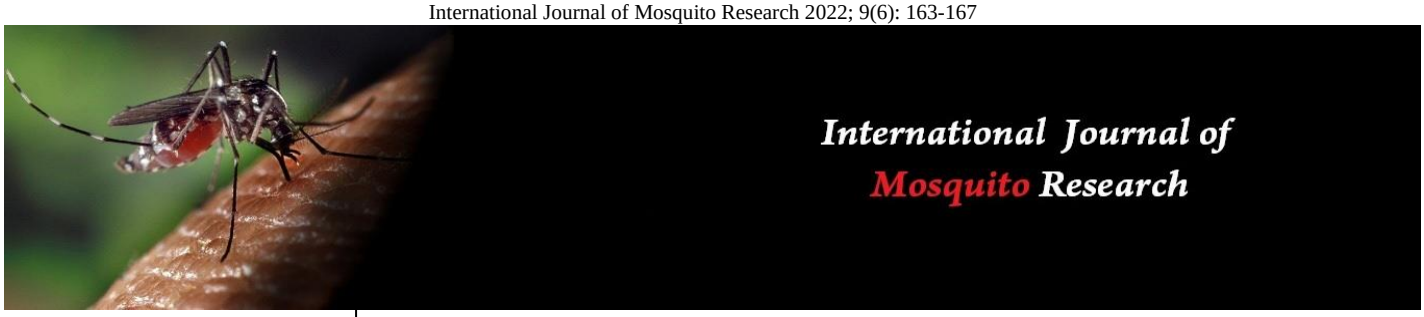

ISSN: **2348-5906**
CODEN: **IJMRK2**
IJMR 2022; 9(6): 163-167

www.dipterajournal.com
Received: 02-09-2022
Accepted: 04-10-2022

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A review of plant diversity effective for controlling mosquito populations

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DOI: https://doi.org/10.22271/23487941.2022.v9.i6b.654

Abstract
In some ecological regions, plants are displaying their diversity and presence dependent on climatic conditions, as well as being influenced by their parental genes. Several biotic and abiotic elements work together to control all aspects of plant life. The presence of plants in a particular area is recorded according to how well they have adapted to changing climatic conditions. The variety of the plants in terms of habit, habitat, adaptation, etc., is sufficient. The plants' various modes of proliferation are also varied. Many plants are multiplied through vegetative means, and some are effective multipliers through both vegetative and reproductive means. The plant also makes enough seeds to continue existing in nature. It has been discovered that the plant can be used both medicinally and for other reasons.
Mosquitoes cause a variety of diseases, including encephalitis, dengue fever, chikungunya fever, filariasis, and malaria. The continued use of synthetic pesticides serves as justification for increased vector species resistance. Human health is impacted by the bioaccumulation of toxic substances through the food chain. Active chemical substances obtained from plants have been utilized as a means of mosquito population control since ancient times. These are available at affordable prices, provide broad-spectrum target-specific activities against a variety of mosquito species, and are biodegradable by nature. Based on the availability of phytochemicals in various plant species that are possible sources for mosquitocidal action, the current review study focuses on Plant Diversity Effective for Controlling Mosquito Populations. 52 plant species were examined in the current study for potential use in reducing mosquito populations. There were 25 different families of plants that were observed. Habitat-wise, 12 kinds of trees, 34 types of herbs, and 6 types of shrubs were noted in wild plants.

Keywords: Plant Diversity, mosquito population, phytochemicals

Introduction
Plants are amazing Bioresource that humans use for a variety of things, including food, fuel, medicine, and other things. They also play a significant role in the establishment of biodiversity in some ecological zones. These are divided into various groups based on the presence of specific compounds. These are likewise listed as significant and vital components of biodiversity. Plants are valuable for managing the environment as well as for regulating the living system. The effect of appropriate climatic conditions and genes on plants affects how they adapt to various ecological settings. The ability of the plants to adapt well helps them thrive in specific ecological settings.
The elements contribute to the successful growth and development of many plant species. Additionally, it gives them a better opportunity to procreate in the same manner as their parents. The duration of such manufacturing using various plant components varies depending on the kind of plant and environmental factors. Many of the numerous plant species are known as medicinal plants, which are of significant medical use to humans. Many of them are referred to as aromatic plants since they also produce specific aromas Both kinds of plants are useful in various ways to treat specific disorders and are widely utilized by people.
These are also remarkable for their multifold utility among the people as well as their role in environmental purification. The varying climatic conditions and genetic makeup of the diverse plant species determine the occurrence of plants. The ability of plants to adapt is also useful in this context. Every plant species is willing to endure long periods of time in nature in order to preserve its its ability to exist.

Plants are notable for having a wide range of ecological site adaptation capabilities. For various plant species to produce a large number of seeds and attain the ability to flourish in various ecological zones, the technique of propagation is a special and flexible process. Some plant species can reproduce by seeds, while others do not. The vegetative portions of these, such as the root, stem, and leaf, as well as their modified forms, such as the bulb, tuber, rhizome, and corm, are well adapted to regeneration.

In the presence of favorable climatic conditions, all dormant plant cells are further used for the same purpose to produce new plants. The development of plants follows a pattern of consecutive growth. At the beginning of plant life, seed germination and bud igniting from vegetative components are important and very valuable activities that serve as a source for the growth of small plants like their mother plants. After plant growth begins, it interacts with its environment constantly, and its ability to fight off predators helps it thrive in the wild. Additionally, it encourages involvement in the composition of plant diversity in certain ecological zones.

Mode of propagation is unique for all species of plants which is an urgent need for their presence and to make copies of the same as their parental ones. This reproduction capacity is helpful to maintain their population and dissemination in natural sites. Seeds production, dispersal and modification of different plant parts take place during the further initiation of the new plant's growth and development followed by the effect of various environmental components.

Review of literature

Aly MZY and Badran RAM. 1996 [1] recorded on Mosquito control with extracts from plants of the Egyptian Eastern Desert. Anees A Mohamed. 2008 [2] found Larvicidal activity of Ocimum sanctum Linn. (Labiatae) against Aedes aegypti (L.) and *Culex quinquefasciatus* (Say). Evaluation of larvicidal and nymphicidal potential of plant extracts against *Anopheles subpictus Grassi*, *Culex tritaeniorhynchus Giles* and *Aphisgossypii* Glover was done by Bagavan A, *et al.* 2009. Chaithong and Udom 2006 focused on Larvicidal effect of pepper plants on Aedes aegypti (L.) (Diptera: Culicidae). Choochote Wej, *et al.* 2004 studied on Potential of crude seed extract of celery, *Apium graveolens* L., against the mosquito *Aedes aegypti* (L.) (Diptera: Culicidae. Choochote Wej, *et al.* 2005 studied on Chemical composition and anti- mosquito potential of rhizome extract and volatile oil derived from *Curcuma aromatica* against *Aedes aegypti* (Diptera: Culicidae).

Preliminary evaluation of mosquito larvicidal efficacy of plant extracts was made by Das NG *et al.* 2007 [7]. De Omena MC, *et al.* 2007 [8] recorded Larvicidal activities against *Aedes aegypti* of some Brazilian medicinal plants. Gopieshkhanna V and Kannabiran K. 2007 [10] focused on Larvicidal effect of *Hemidesmus indicus*, *Gymnema sylvestre* and *Eclipta prostrata* against *Culex quinquefasciatus* mosquito larvae. Govindarajan M, *et al.* 2008 [10]. Studied on effect of *Acalypha indica* L. (Euphorbiaceous) leaf extracts on the malarial vector, *Anopheles stephensi* Liston (Diptera: Culicidae). Jang *et al.* 2005 [12] focused on Mosquito larvicidal activity of active constituent derived from *Chamaecyparis obtusa* leaves against 3 mosquito species. Kamaraj C, *et al.* 2011 [13] found Larvicidal activity of medicinal plant extracts against *Anopheles subpictus* & *Culex tritaeniorhynchus*. Kamaraj *et al.* 2010 [14] recorded Larvicidal and adulticidal potential of medicinal plant extracts from south India against vectors.

Kannathasan and Krishnan 2007 [15] focused on Differential larvicidal efficacy of four species of Vitex against *Culex quinquefasciatus* larvae. Karmegam N, *et al.* 1997 [16] found Indigenous-plant extracts as larvicidal agents against *Culex quinquefasciatus* Say. Khatune NA *et al.* 2001 [17] studied on Laboratory evaluation of Nyctanthes arbor-tristis Linn. Flower extract and its isolated compound against common filarial Vector, *Culex quinquefasciatus* Say (Diptera: culicidae) larvae. Macêdo and Maria E 1997 [18] focused on Screening of Asteraceae (Compositae) plant extracts for larvicidal activity against *Aedes fluviatilis* (Diptera: Culicidae). Maniafu and Barasa M. 2009 studied on Larvicidal activity of extracts from three Plumbago spp against *Anopheles gambiae*. Evaluation of the toxicity of different phytoextracts of *Ocimum basilicum* against *Anopheles stephensi* and *Culex quinquefasciatus was done by* Maurya P *et al.* 2009 [20]. Maurya and Prejwltta 2007 [21] recorded on Larvicidal efficacy of *Aloe barbadensis* and *Cannabis sativa* against the malaria vector *Anopheles stephensi* (Diptera: Culicidae).

Mohan *et al.* 2006 [22] studied on Evaluation of *Solanum xanthocarpum* extract as a synergist for cypermethrin against larvae of the filarial vector *Culex quinquefasciatus* (Say). Larvicidal efficacy of some cucurbitacious plant leaf extracts against *Culex quinquefasciatus* was done by Prabhakar K and Jebanesa A. 2004 [26]. Raghavendra K, *et al.* 2009 [24] studied on Laboratory studies on mosquito larvicidal efficacy of aqueous & hexane extracts of dried fruit of *Solanum nigrum* Linn. Larvicidal efficacy of five cucurbitaceous plant leaf extracts against mosquito species was done by Rahuman *et al.* 2008 [25]. Rajkumar S and Jebanesan A. 2005 [26] studied on Larvicidal and adult emergence inhibition effect of *Centella asiatica* Brahmi (Umbelliferae) against mosquito *Culex quinquefasciatus* Say (Diptera: Culicidae). Rawani and Anjali. 2009 [27] recorded Larvicidal activities of three plants against filarial vector *Culex quinquefasciatus* Say (Diptera: Culicidae).

Sakthivadivel *et al*. 2008 [28] studied on Evaluation of certain insecticidal plants for the control of vector mosquito's *viz*. *Culex quinquefasciatus*, *Anopheles stephensi* and *Aedes aegypti*. Saxena RC *et al.*1992 [29]. Found Laboratory assessment of indigenous plant extracts for anti-juvenile hormone activity in *Culex quinquefasciatus*. Senthil Nathan *et al.* 2006 [30] focused on Effects of *Dysoxylum malabaricum* Bedd. (Meliaceae) extract on the malarial vector *Anopheles stephensi* Liston (Diptera: Culicidae). A review of botanical phytochemicals with mosquitocidal potential was done by Shaalan and Essam Abdel-Salam 2005 [31]. Bioactivity of citrus seed for mosquito-borne diseases larval control was recorded by Sumroiphon and Suchada 2006 [32]. Traboulsi and Abdallah F. 2002 found Insecticidal properties of essential plant oils against the mosquito *Culex pipiens molestus* (Diptera: Culicidae). Yang *et al.* 2003 [34] studied on Emodin isolated from *Cassia obtusifolia* (Leguminosae) seed shows larvicidal activity against three mosquito species."

Materials and Methods

The current paper is based on a review of the research on plants that have been found useful for the control of mosquito populations. Many of the relevant research articles have been studied and the present review made to achieve the goal.

Results and Discussion

The present findings are listed in Table-1.

Table 1: List of Diversity of the Plant Species Effective for Controlling Mosquito Populations

S. No	Plant species	Family	Habit	Plant parts used	Propagation	References
1	*Acacia nilotica* (L.) Delile	Fabaceae	Tree	Leaf	Seed	Saktivadivel & Daniel (2008) [27]
2	*Acalypha indica* L.	Euphorbiaceae	Herb	Leaf	Seed/Stem cutting	Govindarajan *et al.* (2008) [10]
3	*Ageratum conyzoides* L.	Asteraceae	Herb	Leaf	Seed	Saxena *et al.*(1992) [28]
4	*Aloe barbadensis* Mill.	Asphodelaceae	Herb	Leaf	Seed	Maurya *et al.*(2007) [20]
5	*Annona reticulata* L.	Annonaceae	Tree	Stem	Seed	Omena *et al.*(2007) [8]
6	*Annona squamosa* L.	Annonaceae	Tree	Bark	Seed	Kamaraj *et al.*(2010) [12]
7	*Apium graveolens* L.	Apiaceae	Herb	Seed	Seed	Choochate *et al.*(2004) [5]
8	*Argemone mexicana* L.	Papaveraceae	Herb	Leaf	Seed	Karmegan *et al.*(1997) [15]
9	*Aristolochia saccata* Wall.	Aristolochiaceae	Tree	Root	Seed	Das *et al.*(2007) [8]
10	*Azadirachta indica* A. Juss.	Meliaceae	Tree	Leaf	Seed	Bagavan A, *et al.* (2009) [3]
11	*Caesalpinia pulcherrima* (L.) Sw.	Fabaceae	Shrub	Bark	Seed/Stem cutting	Das *et al.*(2007) [7]
12	*Carica papaya* L.	Caricaceae	Shrub	Seed	Seed	Rawani *et al.*(2009) [26]
13	*Cassia obtusifolia* L.	Fabaceae	Herb	Seed	Seed	Yang *et al.*(2003) [33]
14	*Senna tora* (L.) Roxb.	Fabaceae	Herb	Seed	Seed	Jang *et al.*(2005) [11]
15	*Centella asiatica* (L.)Urb.	Apiaceae	Herb	Leaf	Seed	Rajkumar & Jebanesan(2005) [25]
16	*Chrysanthemum indicum* L.	Asteraceae	Herb	Leaf	Seed	Kamaraj *et al.*(2010) [13]
17	*Citrullus vulgaris* Schrad.	Cucurbitaceae	Herb	Leaf	Seed	Prabakar & Jebanesan(2004) [22]
18	*Citrus reticulata Blanco*	Citraceae	Tree	Seed	Seed/Stem cutting	Sumroiphon *et al.*(2006) [31]
19	*Citrus sinensis* (L.) Osbeck.	Citraceae	Tree	Fruit	Seed/Stem cutting	Bagavan *et al.*(2009) [3]
20	*Cleistanthus collinus* (Roxb.) Benth. ex Hook.f.	Phyllanthaceae	shrub	Leaf	Seed	Rawani *et al.*(2009) [26]
21	*Cleome droserifolia* (Forssk.) Delile	Cleomaceae	Herb	Leaf	Seed	Aly & Bardan(1966) [1]
22	*Cleome icosandra* L.	Cleomaceae	Herb	Leaf	Seed	Saxena *et al.*(1992) [28]
23	*Coccinia indica* Wight & Arn.	Cucurbitaceae	Herb/Climber	Leaf	Seed	Rahuman & Venkatesan (2008) [24]
24	*Curcuma aromatic* Salisb.	Zingiberaceae	Herb	Rhizome	Rhizome	Choochate *et al.*(2005) [6]
25	*Daucus carota* L.	Apiaceae	Herb	Leaves	Seed	Shaalan *et al.*(2005) [30]
26	*Eucalyptus globules* Labill.	Myrtaceae	Tree	Seed and leaf	Seed	Shaalan *et al.* (2005) [30]
27	*Euphorbia tirucalli* L.	Euphorbiaceae	Shrub	Stembark	Seed	Rahuman *et al.*(2007) [24]
28	*Eclipta prostrata* (L.) L.	Asteraceae	Herb	Leaf,root	Seed	Khanna & Kannabiran(2007) [81]
29	*Euphorbia hirta* L.	Euphorbiaceae	Herb	Stem bark	Seed	Rahuman *et al.*(2008) [26]
30	*Hemidesmus indicus* (L.) R. Br. ex Schult.	Apocynaceae	Herb/Climber	Root	Seed	Khanna& Kannabiran(2007) [14]
31	*Jatropha curcas* L.	Euphorbiaceae	Herb	Leaf	Seed	Saktivadivel & Daniel(2008) [22]
32	*Melia azedarach* L.	Meliaceae	Tree	Leaf and seeds	Seed	Senthil Nathan *et al.*(2006) [29]
33	*Mentha microcephylla* Strail	Lamiaceae	Herb	Leaf	Stem cutting	Traboulsi *et al.*(2002) [32]
34	*Momordica charantia* L.	Cucurbitaceae	Herb/Climber	Fruit	Seed	Singh *et al.*(2006) [25]
35	*Moringa oleifera* Lam.	Moringaceae	Tree	Bark	Seed/Stem cutting	Kamaraj& Rahuman(2010) [13]
36	*Murraya paniculata (*L.) Jack	Rutaceae	Shrub	Fruit	Seed	Rawani *et al.*(2009) [26]
37	*Myrtus communis* L.	Myrtaceae	Shrub	Flower and Leaf	Seed	Traboulsi *et al.*(2002) [32]
38	*Nyctanthes arbortristis* L.	Oleaceae	Tree	Flower	Seed/Stem cutting	Khatune *et al.*(2001) [16]
39	*Ocimum sanctum* L.	Lamiaceae	Herb	Leaf	Seed/Stem cutting	Anees(2008) [2]
40	*Ocimum basilicum* L.	Lamiaceae	Herb	Leaf	Seed/Stem cutting	Maurya *et al.*(2009) [20]
41	*Ocimum gratissimium* L.	Lamiaceae	Herb	Leaf	Seed/Stem cutting	M.**B**erasa *et al.*,(2009) [18]
42	*Pedilanthus tithymaloides* (L.) Poit.	Euphorbiaceae	Herb	Leaf	Seed	Rahuman *et al.*(2007) [24]
43	*Pergularia extensa* (Jacq.) N.E. Br.	Apocynaceae	Herb/Climber	Leaf	Seed	Karmegan *et al.*(1996) [15]
44	*Phyllanthus amarus* Schumach. & Thonn.	Phyllanthaceae	Herb	Leaf	Seed	Rahuman *et al.*(2007) [24]
45	*Piper longum* L.	Piperaceae	Herb/Climber	Fruit exocarp	Seed/Stem cutting	Chaithong *et al.*(2006) [4]
46	*Plumbago zeylanica* L.	Plumbaginaceae	Herb	Root	Seed/Stem cutting	Maniafu *et al.*(2009) [18]
47	*Solanum xanthocarpum* Schrad. & H. Wendl.	Solanaceae	Herb	Root	Seed	Mohan *et al.*(2006) [21]
48	*Solanum nigrum* L.	Solanaceae	Herb	Dried fruit	Seed	Raghavendra *et al.*(2009) [23]
49	*Tagetes minuta* L.	Asteraceae	Herb	Aerial parts	Seed	Macedo *et al.*(1997) [17]
50	*Tradescantia zebrine* Bosse	Commelinaceae	Herb	Leaf	Seed/Stem cutting	Kamaraj *et al.*(2011) [12]
51	*Tridax procumbens* (L.) L.	Asteraceae	Herb	Leaf	Seed	Kamaraj *et al.*(2011) [12]
52	*Vitex negundo* L.	Lamiaceae	Tree	Leaf	Seed/Stem cutting	Krishnan *et al.*(2007) [14]

Table 2: Family wise distribution of the Plants.

S. No	Family	Number of the Plants
1.	Annonaceae	2
2.	Apiaceae	3
3.	Apocynaceae	2
4.	Aristolochiaceae	1
5.	Asphodelaceae	1
6.	Asteraceae	5
7.	Caricaceae	1
8.	Citraceae	2
9.	Cleomaceae	2
10.	Commelinaceae	1
11.	Cucurbitaceae	3
12.	Euphorbiaceae	5
13.	Fabaceae	4
14.	Lamiaceae	5

15.	Meliaceae	2
16.	Moringaceae	1
17.	Myrtaceae	2
18.	Oleaceae	1
19.	Papaveraceae	1
20.	Phyllanthaceae	2
21.	Piperaceae	1
22.	Plumbaginaceae	1
23.	Rutaceae	1
24.	Solanaceae	2
25.	Zingiberaceae	1
Total		52

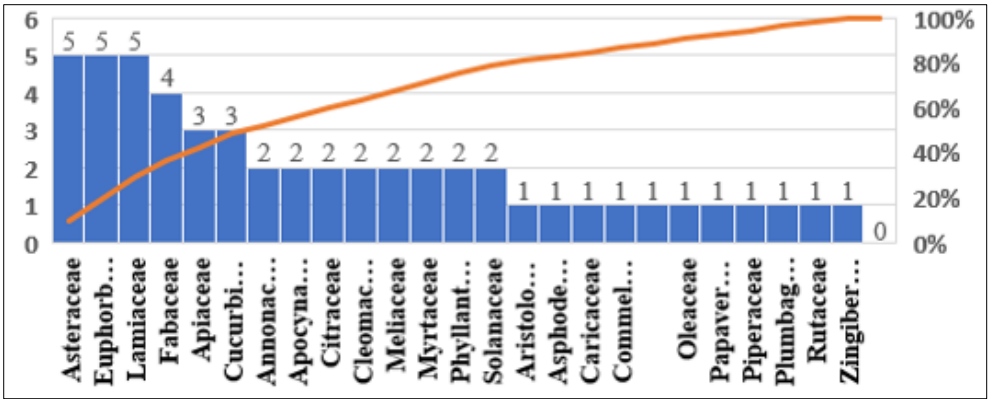

Fig 1: Family wise distribution of the plants.

Table 3: Habit-wise category of the plants

S. No	Habit	Number of Plants
1	Tree	12
2	Herb	34
3	Shrub	6
Total		52

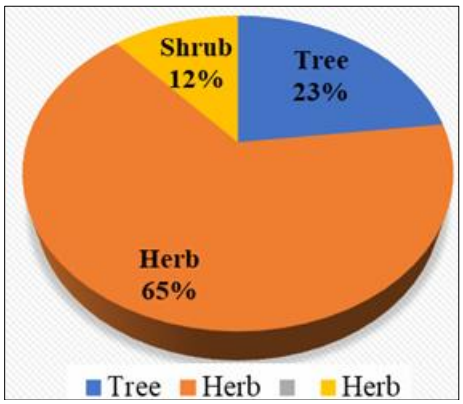

Fig 2: Number of plants

Discussion

In present study there are 52 Plant species were reviewed for their potential application in controlling mosquito populations. The recorded plants were of 25 different families. Habit wise 12 recorded for Tree species, 34 for Herbs and 06 for Shrubs nature plants were recorded. Because each bioassay system has different tests, there are no standards for the materials used, and each bioassay system has basic activities, it is difficult to compare the repellency results from different bioassays. In order to avoid repeating trials and testing and to quickly achieve some helpful results, a global issue involving mosquitoes as carriers of some of the most important disease-causing pathogens demands coordination across all working groups under one umbrella project. Currently, phytochemicals make up just under one percent of the worldwide pesticide market. Identification, isolation, and mass production of bioactive compounds are crucial for the prevention of diseases spread by mosquitoes.

The findings of a previous study on the effectiveness of plants in reducing mosquito populations spurred additional inquiry in this area. Promoting the growth of such efficient plant species in all available locations should be focused. These eco-friendly methods can lessen the negative effects of mosquitoes on people.

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