

Insect and Non-Insect Pests Associated with Drumstick, *Moringa oleifera* (Lamk.)

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Abstract

The aim of this review article is to provide the basic information on insect and non-insect pests of drumstick, *Moringa oleifera* Lam. at different stages of crop growth as well as their nature of damage. The literature on the insect and non-insect pests of drumstick and their seasonal incidence is scanty. Therefore this information will help to understand the different kinds of insect pests occurring on drumstick. It is also intended to determine type of control measures can adopt against these pests.

Keywords: Drumstick; Insects pests; Non-insect pests; Nature of damage; Seasonal incidence

Introduction

The Indian subcontinent is the cradle of many economically important vegetable crops. Among them, drumstick is an important vegetable crop rich in minerals and vitamins, grown by the Dravidians and as well by the Aryans in each and every home yard. Over the past ten years there has been a rapid growth in interest surrounding drumstick. Considerable new research has been done on its cultivation, extraction of its seed oil, use in agro-forestry systems, water purification properties and its medicinal and nutritional benefits. It has the great potential to become one of the most economically important tree crops for the tropics and sub-tropics.

But this miracle tree is susceptible to many insects pests [1-7] namely bark eating caterpillar, *Inderbela quadrinotata* (Wlk.), caterpillar pests, *Eupterote mollifera* Walker, and *Noorda blitealis* Walker, bud worm, *Noorda moringae* Tams., stem borers, *Inderbela tetraonis* (Moore), *Diaxenopsis apomecynoides* (Bruning), and *Batocera rubus* L., ash weevils, *Myllocerus viridanus* (Fab.), *Myllocerus discolor* var. *variegatus* Boheman, *Myllocerus delicatulus* Boheman, aphids, *Aphis craccivora* Koach, leaf eating caterpillar, *Tetragonia siva* Lef., *Metanastria hyrtaca* (Cramer), Tea mosquito bug, *Helopeltis antonii* (Sign.), bud midges, *Stictodiplosis moringae* Mani, scale insects, *Diaspidiotus* sp., *Ceroplastodes cajani* (Mask.). A few aphids feeding on the terminal end of the fruit causing tip drying has been recorded. Termites are other pests associated with drumstick. Of late drumstick fruit fly, *Gitona distigma* (Meigen) a palaeartic species reported for first time in India has become one of the most serious pests of drumstick. In the recent years, damage by the fruit fly is increasing especially during rainy season. Infestation of this pest starts from fruit initiation and persists till harvesting stage. Pod fly has attained a major pest status in Southern India [8] This pest is reported to cause 70 per cent loss under poor management conditions [9].

Butani and Verma [5] gave a list of 28 species of insects and two species of mite pests attacking drumstick. Likewise many workers reported different insects on drumstick. Such of the insect and non-insect pests on drumstick, as reported by different workers, have been enlisted in Table 1. Accordingly, 49 insect pests and four mite pests have been found to infest drumstick. Mites, aphids, imported cabbageworm (*Pieris rapae*) and borers causing trunk damage have been observed on drumstick at Nigeria [10].

Similarly, Ojiako et al., [11] identified several nursery insect pests of *M. oleifera* Lam. in Owerri, Nigeria, but added that such attacks were of non-significant nature. Several other insect pests causing minor or only occasionally serious damage have also been reported. The insects identified were mainly: *Zonocerus variegatus* Linnaeus (variegated grasshopper), *Musa domestica* Linnaeus (house fly), *Formica rufa* Linnaeus (red wood ant), *Lagria villosa* Fabricus (leaf-eating beetle), *Oedaleus nigeriensis* Uvarov (Nigerian grasshopper) and *Homorocoryphus nitidulus vicinus* Walker (edible or long-horned grasshopper).

Okonkwo et al., [12] also investigated the diversity of higher invertebrate fauna living in close association with drumstick at Nigeria. They reported the insects and related arthropods found on drumstick-included caterpillars, aphids, weevils, spiders and mites. Other invertebrate animals included tree and land snails. These have pale white shells with dark brown notches as ornamentation. The species recorded included *Achatina* sp. and *Helix* sp., both of which are land and tree snails, respectively. The *Araneae* and *Acarina* (spiders and mites, respectively) of the class Arachnida included 52 aerial, web-building spiders (29.7% of total) and numerous green mites. The insect groups made up about 61% of the invertebrate collections, including 50 specimens of black and orange-yellow ants, 13 black hairy caterpillars, 13 weevils and 19 lady bird larvae.

Sl. No	Common Name	Scientific Name	Family and Order	Alternate host	Reference
A	Borers/Internal feeders				
1.	Pod fly	<i>Gitona distigma</i> (Meigen)	<i>Drosophilidae:</i> Diptera	–	[13-15]
2.	Pod fly	<i>Gitona</i> sp.	<i>Drosophilidae:</i> Diptera	–	[16,1,17,5,18]
3.	Shoot fly	<i>Atherigona</i> sp.	<i>Muscidae:</i> Diptera	Sorghum	[15]
4.	Bud borers/ budworm	<i>Noorda moringae</i> Tams	<i>Crambidae:</i> Lepidoptera	–	[19,20,5,21,22,18,15]
5.	Fruit feeders	<i>Oxycetonia versicolor</i> Fb.	<i>Scarabaeidae:</i> Coleoptera	–	[5,23,18]
6.	Fruit fly	<i>Diarrhegma modestum</i> (Fabricius))	<i>Diptera:</i> Tephritidae		[24,25]
7.	Bud worm/ Leaf eating caterpillar	<i>Protrigonia zizaniaalis</i> Swinhoe	<i>Crambidae:</i> Lepidoptera	–	[26,21,18]
8.	Bud midge	<i>Stictodiplosus moringae</i> Mani	<i>Cecidomyiidae:</i> Diptera	–	[19,27]
9.	Cut worm/fruit borer/ shoot borer	<i>Helicoverpa armigera</i> Hubner	<i>Noctuidae:</i> Lepidoptera	Brinjal, Okra, Chilli, Bittergourd and Onion.	[16,21,28]
10.	Cut worm	<i>Spodoptera litura</i> (Fab.)	<i>Noctuidae:</i> Lepidoptera	Amaranthus, Cowpea and Garden pea	[29,18]
11.	Bark borer	<i>Indarbelia tetraonis</i> (Moore)	<i>Indarbelidae:</i> Lepidoptera	Albizia lebeck Benth and Casurina equisetifolia Forsti	[5,21,28,22]
12.	Bark borer	<i>Indarbelia</i> spp	<i>Metarbelidae:</i> Lepidoptera	-	[15]
13.	Stem borer	<i>Indarbelia quadrinotata</i> Walker	<i>Indarbelidae</i> Lepidoptera	Mango, Guava citrus, Jujube, Cashew and Litchi	[2,30]
B	Defoliators				
14.	Leaf eating caterpillars	<i>Noorda blitealis</i> Walker	<i>Crambidae:</i> Lepidoptera		[19,20,22,31,5,21,18,15]
15.	Hairy caterpillars	<i>Eupterote mollifera</i> Walker	<i>Eupterotidae:</i> Lepidoptera	Acacia arabica, Tamarind and Nerium	[32,26,5,21,18]
16.	Hairy caterpillars	<i>Eupterote geminata</i> Walker	<i>Eupterotidae:</i> Lepidoptera		[5,21]
17.	Hairy caterpillars	<i>Metanastris hyrtaca</i> (Cramer)	<i>Lasiocampidae:</i> Lepidoptera	Mimus elengi, Terminalia catapa, Nyctanthus arbortristisia, Sapota, Guava, Eugenia and Acacia arabica.	[32,21]
18.	Hairy caterpillar	Undetermined	<i>Lymantridae:</i> Lepidoptera	-	[15]

19.	Tussock caterpillars	<i>Euproctis lunata</i> (Walker)	<i>Lymantridae</i> : Lepidoptera	Cotton, Acacia Arabica, Tamrind, Nerium and Chrysanthemum	[18,33]
20.	Wooly bear moth/ Tiger moth	<i>Pericallia ricini</i> (Fabricius)	<i>Arctiidae</i> : Lepidoptera	Elephant foot yam, banana, Coccinia, Brinjal, Cowpea, sweet potato, Radish, Arum and Pumpkin.	[32,20,5,21,18]
21.	Tiger moth	<i>Amata passalis</i> Fabricius	<i>Erebidae</i> : Lepidoptera		[15]
22.	Hairy caterpillars	<i>Taragama siva</i> Lef	<i>Lasiocampidae</i> : Lepidoptera	Acacia arabica, Rose, Polyalthia longifolia, Tamarix gallica	[33,28]
23.	Miner-cum webber	<i>Protrigonia zizanialis</i> Swinhoe	<i>Pyraustidae</i> : Lepidoptera	–	[34,18]
24.	Leaf eating caterpillar	<i>Actias selene</i> Hubner	<i>Saturniidae</i> : Lepidoptera	–	[32,21]
25.	Leaf eating caterpillar	<i>Ascotis selenaria imparata</i> Walk.	<i>Geometridae</i> :Lepidoptera	-	
26.	Leaf feeding caterpillar	<i>Ulopeza phaeothoracica</i> Hampson	<i>Lepidoptera</i> : Crambidae	-	[35]
27.	Painted Grasshopper	<i>Poeciloceris pictus</i> Fab.	<i>Pyrgomorphidae</i> : :Or thoptera	–	[18]
28.	Grass hoppers	<i>Chrotogonus</i> sp.	<i>Pyrgomorphidae</i> : Orthoptera		[15]
29.	Grass hoppers	<i>Atractomorpha crenulata crenulata</i> (Fabricius)	<i>Pyrgomorphidae</i> : Orthoptera		[15]
30.	Grass hoppers	<i>Pyrgomorpha bispinosa bispinosa</i> (Walker)	<i>Pyrgomorphidae</i> : Orthoptera		[15]
C Sucking insects/ Sap feeders					
31.	Aphids	<i>Aphis craccivora</i> Koach	<i>Aphididae</i> : Hemiptera	Lab lab, Ground nut, Cluster bean, Gliricidia, Gynadro psis pentaphylla, Indigofera sp. and Sesbenia grandiflora Bogdon	[36,18,15]
32.	Cotton Aphid	<i>Aphis gossypii</i> Glover	<i>Aphididae</i> :Homoptera	Cotton	[22,37]
33.	White fly	<i>Trialeurodes rara</i> Singh	<i>Aleyrodidae</i> : Hemiptera	–	[5]
34.	White fly	<i>Aleurodicus dispersus</i> Russel	<i>Aleyrodidae</i> : Hemiptera	–	[18]
35.	Whitefly	Undetermined	<i>Aleyrodidae</i> : Hemiptera	-	[15]
36.	Scale insect	<i>Ceroplastodes cajani</i> Marshall	<i>Coccidae</i> : Hemiptera	Redgram, lab lab, Zizyphus, Tephrosia candida (Roxb), Coleus and Ocimum sanctum Linn.	[38,16,5]

37.	Hard scale	<i>Diaspidiotus</i> sp.	<i>Diaspididae</i> : Homoptera	–	[38,5]
38.	Thrips	<i>Ramaswamihiella subnudula</i> Karny	<i>Thripidae</i> Thysonoptra	–	[5,18]
39.	Flower thrips	<i>Thrips tabaci</i>	<i>Thripidae</i> : Thysonoptera	Ziziphus mauritiana, Parkinsonia, aculeate and Cassia siamea	[40]
40.	Flower thrips	<i>Megalurothrips distalis</i> Karny	<i>Thripidae</i> : Thysonoptera	Ziziphus mauritiana Lam., Parkinsonia, aculeate and Cassia siamea	[40]
41.	Flower thrips	Undetermined	<i>Thripidae</i> : Thysonoptera	-	[15]
42.	Pentatomid bug	<i>Cyclopelta succifolia</i> Westwood	<i>Pentatomodae</i> : Homoptera	–	[5]
43.	Tea mosquito bug	<i>Helopeltis antonii</i> (Sign)	<i>Miridae</i> : Hemiptera	Tea, Cashew, Guava and Grapevine	[3,18]
44.	Green bug	<i>Nezara viridula</i> Linn.	<i>Pentatomidae</i> : Hemiptera	–	[18]
45.	Red cotton bug	<i>Dysdercus similis</i> Freeman	<i>Pyrrhocoridae</i> : Hemiptera)	Cotton	[18,15]
46.	Tree hoppers	<i>Leptocentrus</i> sp.	<i>Membracidae</i> : Hemiptera	–	[18]
47.	Tree hoppers	<i>Otinotus</i> sp.	<i>Membracidae</i> : Hemiptera	–	[15]
48.	True bugs	<i>Spilostethus pandrurus</i> (Scopoli)	<i>Lygaeidae</i> : Hemiptera	–	[15]
49.	Red bug	<i>Leptocoris</i> sp.	<i>Rhopalidae</i> : Hemiptera	–	[15]
50.	Dusky cotton bug	<i>Oxycarenus hyalinipennis</i> (Costa)	<i>Lygaeidae</i> : Hemiptera	–	[15]
51.	Painted bug	<i>Halyomorpha picus</i> (Fabricius)	<i>Pentatomidae</i> : Hemiptera	–	[15]
52.	Jewel bug	<i>Chrysocoris stollii</i> Wolf	<i>Scutelleridae</i> : Hemiptera	–	[15]
D	Beetles and Weevils/Stem borers/Bark feeders				
53.	Longhorn beetle	<i>Batocera rubus</i> (Linnaeus)	<i>Cerambycidae</i> : Coleoptera	–	[41,5,43,18]
54.	Stem borer	<i>Coptops aedificator</i> (Fabricius)	<i>Cerambycidae</i> : Coleoptera	–	[5]
55.	Stem borer	<i>Monohammus</i> spp.	<i>Cerambycidae</i> : Coleoptera	–	[41,5]
56.	Stem borer	<i>Diaxenopsis apomecynoide</i> (Bruning)	<i>Cerambycida</i> Coleoptera	–	[43,5,16]
57.	Stem Girdler	<i>Sthenias grisator</i> (Fabricius)	<i>Cerambycidae</i> : Coleoptera	Grape	[15]

58.	Flower beetle/ flower chaffer beetle	<i>Gametes versicolor</i> (Fabricius)	Scarabaeidae: Coleoptera	–	[15]
59.	Chaffer Beetle	<i>Protaetia peregrina</i> (Herbst)	Scarabaeidae: Coleoptera	–	[15]
60.	Chaffer Beetle	<i>Protaetia alboguttata</i> Vigors	Scarabaeidae: Coleoptera	–	[15]
61.	Blister beetle	<i>Zonabris pustulata</i> Thunb	Meloidae: Coleoptera	–	[15]
62.	White grub	<i>Holotrichia insularis</i> Brenske	Scarabaeidae: Coleoptera	–	[44,5]
63.	Ash weevil	<i>Mylocerus viridanus</i> (Fab.)	Curculionidae: Coleoptera	–	[41,5,18,15]
64.	Ash weevil	<i>Mylocerus teniclavis</i> var. <i>inferior</i> Marshall	Curculionidae: Coleoptera	–	[41,5]
65.	Ash weevil	<i>Mylocerus 11- pustulatus</i> Fst	Curculionidae: Coleoptera	Cotton, Castor, Cholam and Bhendi	[41]
66.	Ash weevil	<i>Mylocerus discolor</i> var. <i>variegates</i> Boheman	Curculionidae: Coleoptera	Cholam, Maize, cotton, Redgram and Guava	[41,18,15]
67.	Ash weevil	<i>Ptochus ovulum</i> Fst.	Curculionidae: Coleoptera	Amaranthus, Beet root, Bhendi, Gliricidia maculata	[41]
68.	Ash weevil	<i>Mylocerus delicatulus</i> Boheman	Curculionidae: Coleoptera	–	[18]
69.	Weevil	<i>Ptochus ovulum</i> Fst.	Curculionidae: Coleoptera	Amaranthus, Beet root, bhendi, Gliricidia maculata and Millingtonia	[41]
70.	Ash weevils	<i>Mylocerus</i> sp.	Curculionidae Coleoptera	–	[15]
71.	Beetle grub	<i>Holotrichia reynaudi</i> Blanchard	Melolonthidae: Coleoptera	–	[44]
72.	Termite	<i>Microtermes</i> spp.	Kalotermitidae: Isoptera	–	[45]
73.	Termite	<i>Odontotermes</i> sp.	Kalotermitidae: Isoptera	–	[45]
E	Non-insect pests				
1.	Mites	<i>Tetranychus neocaledonicus</i> (Andre)	Tetranychidae: Acarina	–	[46]
2.	Mite	<i>Aculus menoni</i> Channabasavanna	Eriophyidae: Acarina	–	[5]
3.	Mite	<i>A. Moringae</i> Channa basavanna	Eriophyidae: Acarina	–	[5,47,18]
4.	Mite	<i>A. pterigospermae</i> Keifer	Eriophyidae: Acarina	–	[47,18]
5.	Land snails and tree	<i>Achatina</i> sp. and <i>Helix</i> sp.	(Mollusca: Gastropoda)	–	[12]

Table 1: Insect and non- Insect pests reported on drumstick (*Moringa olifera* Lamk.).

Among the piercing and sucking insects were numerous green and brown/black aphids, whiteflies and mealy bugs. Others included praying mantis (9) and two small adult cockroaches and one dragonfly.

Recently, Mahesh and Kotikal [15] investigated 31 species of insects occurring on drumstick crop at various stages. Among them, four species viz., *Gitona distigma* (Meigen), *Noorda blitealis* Walker, *Noorda moringae* Tams, and *Mylocerus* spp. were considered as major

pests. Remaining species recorded as minor pests on drumstick viz., aphids, *Aphis craccivora* Koch, white fly and flower thrips were found to occur occasionally.

Borers/Internal feeders

The incidence of stem borer beetle, *Diaxenopsis apoecynoides* (Bruning) was seen high during the months of September to November. The larvae of the Cerambycid beetle were noted to bore into the tender shoots of moringa [43]. The lab lab scales, *Ceroplastodes cajani* M. was observed to occur during January to February and August to December on moringa. In Puerto Rico, moringa trees are highly susceptible to attack by termites, and heavy seed predation by an unidentified insect was often found [7].

Ali et al.[30] studied the seasonal occurrence of developmental stages (viz., larvae, pupae and adult moth), status of *Indarbela quadrinotata* Walker on different growth stages of woody perennials and its host specificity to some host plants in Bihar plains revealed high occurrence and more susceptibility of the pest stage from sapling to tree stage of *Albizia lebbbeck*, *B. variegata*, *G. arhorea*, *M. oleifera* during February to October and low to moderate occurrence from seedling to tree stage. Bark caterpillar, *Inderbela tetraonis* causes severe damage drumstick. On hatching caterpillars feed superficially below bark, making zig zag galleries and later bore inside bark or main stem, remain within these burrows during day but come out at night and feed on bark [37].

Stem borer, *Batocera rubus* Linn. distributed all over the Indian subcontinent. Eggs laid singly in cracks or crevices in the bark of the tree. On hatching grubs make zig zag burrow beneath the bark, feed on internal tissues, reach sapwood and cause death of affected branch or stem [38].

Diarrhagma modestum (Fabricius) has been reported from India (West Bengal, Karnataka and Tamil Nadu) where it breeds in the pods of drumstick, *M. oleifera* Lam. used as vegetable in India [24]. For the first time the occurrence of *D. modestum* (Fabricius) was reported from Bangladesh [25].

The pod fly, *Gitona distigma* (Meigen), a palaeartic species reported for the first time in India [48] has attained a major pest status in Southern India [8]. It is reported to cause 70 per cent loss under poor management conditions [49]. Economic injury level (EIL) for this pest is 15 per cent of affected fruits [50]. The maggots of *Gitona* sp. have been found to bore into the developing fruits and feed on pulp and seed. Oozing of gum out of fruits, splitting of fruits and drying of fruits from the tip upwards to the base of the fruit stalk are indications of the prevalence of the pest [18].

Recently, Mahesh and Kotikal [15] reported infestation by the pod fly, *G. distigma* (Meigen) was 35.10 per cent. Pod fly adult was small with transparent wings with two black spots on forewing, having red coloured compound eyes. The resulting creamy white maggots were found to feed on the developing pods, on pulp and also on seed. As a result of which oozing of gum from pods, splitting of pods and drying of pods from the tip to the base of the pod stalk, were the main symptoms observed to be caused by the pest.

Flower feeders/bud borers

The larva bores into flower buds and causes shedding to a large extent. *Noorda moringae* Tams occurred in South India which caused 78 per cent bud damage when the infestation was severe [37]. Usha

Rani et al., [37] also reported bud midge, *Stictodiplosis moringae* larvae were found to feed on the internal content of the flower buds causing shedding of buds in large numbers. Adult fly is free living, small and brown coloured.

The caterpillars were noticed to bore into the flower buds, due to which, the bored buds dry and drop. The unopened buds with a hole are indications of damage by this insect. The incidence of *N. moringae* was observed throughout the year except during December, with an average bud damage of 17.08 per cent. The maximum bud borer incidence was noticed in second fortnight of February with 54 per cent bud damage while the minimum was 2.0 per cent [15].

Defoliators/ Leaf feeders

Butani and Verma [5] observed maximum damage by *Noorda blitealis* Walker during March to April and December to January. Leaf eating caterpillar is considered to be the most serious pest of annual moringa as it occurs throughout the year and causes serious damage to the crop [17]. The leaf caterpillar, *N. blitealis* Walker was seasonal and found to occur during January to April in Periyakulam, Tamil Nadu [23].

Munj et al., [51] reported *N. blitealis* infestation in Konkan region of Maharashtra, having three peak periods of defoliation, the first during July to August, second during October and third during January. The pest was active throughout the year and the maximum population was noticed during January and the lowest population during May to June. [52] observed the severity of *Euproctis lunata* Walker during February and March 2002 on *Acacia* trees in Thailkulam, Virudhunagar, Tamil Nadu, India. The larvae were found gregariously on *Acacia* trees in social forest plantations. *Tamrind*, *Nerium*, *Chrysanthemum*, *Moringa* and other weed flora served as alternate hosts for the larval swarms.

Satti et al., [53] reported that *N. blitealis* has become an important leaf defoliator of drumstick species in Sudan. In India, the larvae of *N. moringae* bore into flower buds of drumstick causing shedding of up to 75% of the buds (TNAU Agritech, 2014), while the *E. mollifera* feed gregariously by scrapping and gnawing foliage resulting in complete defoliation of the tree during severe infestation.

Mahesh and Kotikal [15] observed the early instars of *N. blitealis* Walker feed on the leaves by scrapping the chlorophyll content resulting the papery appearance of leaves and later instars feed on entire leaves by leaving only veins behind. In severe infestation, the trees were almost without leaves resulting in 100 per cent damage to foliage. Female moth laid creamy, oval eggs on under surface of leaves and after hatching the larvae started feeding on leaves by scrapping. The incidence was observed throughout the year. Maximum larval population of *N. blitealis* was noticed during second fortnight of April 2013 with a population of 11.2 larvae per branch followed by second fortnight of October with a population of 7.8 larvae per branch.

Yusuf and Yusif [35] from Nigeria reported the leaf caterpillar, *Ulopeza phaeothoracica* Hampson larvae found to feed on leaf lamina, turning them into transparent parchment structures as or in some cases a creating a window like opening on the leaf of drumstick. [15] observed that three species of grass hoppers were found to feed on to feed on leaves and cut the tender shoots. These grass hoppers were recorded during the vegetative and flowering stage.

Sucking insects/ Sap feeders

The tender shoots, as well as the fruits and their stalk were fully covered by the scale in the case of severe attack, the tender shoots dried up [38] Aphids, *Aphis craccivora* Koach, have been observed to infest the tender shoots of moringa during January to March on the under surface of leaflets [36].

White fly, *Trialeurodes rara* Singh, Scale insect, *Ceroplastodes cajani* Mashell and *Diaspidiotus* sp. and a pentatomid, *Cyclopelta siccifolia* Westwood have been recorded sucking the sap from ventral surface of leaflets and tender twigs. Thrips, *Ramaswamihiella subnudula* Karmy, a polyphagus pest has also found to feeding and breeding in inflorescence of drumstick [5].

Scale, *Ceroplastodes cajani* both nymphs and adults suck the sap and affect the vigour of the plants. Though each insect takes only a few drops of sap during its life time presence of enormous number of insects sucking the sap continuously at times, weakness trees and ultimately affects size of fruits [37].

Palada and Chang [55] and Radovich [10] noted that even though drumstick may be resistant to most pests and diseases, spider and mite populations could increase during dry and cool weathers, thereby causing leaf yellowing. They normally constitute the biggest economic problem according to [10] because of the potential for rejecting shipments of drumstick from the producing areas of Hawaii to North America. Numerous white flies (*Bermisia* sp.) were recorded by [12]. Palada and Chang [55] also reported prevalence of white flies among other insect pests of drumstick in India.

Cotton Aphid, *Aphis gossypii* both nymphs and adults damage the tender shoots [38]. The nymphs of Aphids, *A. craccivora*, a small brown coloured aphid, were observed on leaves. Both the nymphs and adults suck the sap and cause the yellowing of leaves and drying of leaves. Incidence of aphids was noticed during second fortnight of February to first fortnight with an average population of 0.83 per compound leaf [15].

Both the nymphs and adults of tree hoppers, *Otinotus* sp. suck the sap from the tender shoots. Population was noticed during vegetative stage. These were observed to be active on the tender shoots in groups associated with black ants, *Camponotus campressus* (Fabricius) [15].

Beetles and Weevils

The longicorn beetles, *Batocera rurus* Linnaeus, *Captops aedifactor* Fabricius and *Monohammus* sp. have been recorded boring the stems. *Monohammus* sp. is most common in South India. The females excavate small cavities in the stems and deposit one or two eggs in each cavity. On hatching the grubs bore into the stems, sealing the entrance with their excreta; as a result, the growing points of stems get wilted and started drying, shedding of all the leaves [5]. From Rajasthan, White grub, *Holotrichia insularis* Brenske has been reported as a serious leaf defoliator. Grubs feed on all sorts of roots and pupate in the soil. Adult on emergence stay in the soil till the early monsoon showers, when they come out at night and feed voraciously on foliage [44]. Usha Rani et al., [37] reported white grubs feeds on roots and adult beetles feeds on leaves. Adults come out with monsoon during June-July.

Subramaniam [41] observed the five species of weevils *Myloccerus* causing damage to the leaves of drumstick plant at Coimbatore. The weevil cause appreciable damage to the leaves. The adults congregate

on tender leaves, mostly on the undersurface and nibble the leaves, starting from the margins and nibble the leaves, starting from the margins and working towards the midrib, finally consuming the entire leaf blade.

The adult weevils cause notching of leaves. Grubs feeds on roots and causes wilting of plants [37]. Three species of Ash weevils, *Myloccerus viridanus* Fabricius, *Myloccerus discolor* (Boheman) and *Myloccerus* sp., were recorded by [15] on drumstick. *Myloccerus viridanus* is a small weevil having uniform pale greenish white scaling on the body, which often exhibits chalky white efflorescence. The head is tinged with yellow and the elytra do not have any markings. Incidence was observed throughout the year with an average population of 1.30 adult weevils per branch. *Myloccerus discolor* is larger than the *M. viridanus*. It has a uniform dull greyish brown scaling on the body and the elytra are variegated with large irregular pale grey blotches mingled with small grey spots. The adults of an undetermined species of *Myloccerus* were observed to damage drumstick in the month of July to December with an average of population of 6 adult weevils per branch.

Non-insect pests

Feeding activity of the vegetable mite, *Tetranychus neocaledonicus* (Andre) on *M. oleifera* led to the formation of conspicuous white spots, manifested through chlorosis of the leaves. Affected leaves exhibited chlorophyll loss and subsequent drying up and shedding. Cattle, sheep, pigs, and goats were found to eat drumstick seedlings, pods and leaves and also reported mites populations can increase during dry and cool weather [55].

Recorded significant loss ($p < 0.01$) in chlorophyll content of *M. oleifera* leaves due to infestation by *T. neocaledonicus* regardless of the developmental stages of the mite [56]. Mites are vagrants on both the surfaces of leaves causing no apparent damage symptoms to its host [57]. Mites are vagrants on leaf and stem showing no injury to its host.

Conclusion

From this review article, it is clear that different insect and non-insect pest associated with drumstick from different parts of the world. Some of the insect pests cause major threats to drumstick cultivation and they occur at particular season. Therefore, it is necessary to understand their seasonal occurrence and nature of damage caused by these insect and non- insect pests. By understanding the insects, it helps us to take effective control measures at particular season.

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