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Research Paper

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.

Key words: 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 (Kareem *et al*., 1974; Verma and Khurana, 1974; Pillai *et al*., 1979; Ramachandran *et al.,* 1980; Butani and Verma, 1981; Morton, 1991; Parrota, 2009), namely bark eating caterpillar, *Inderbela quadrinotata* (Wlk.), caterpillar pests, *Eupterote mollifera* Walker, and *Noorda blitealis* Walker, bud worm, *Noorda moringae* Tams., stem borers, *Indarbela 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 palaearctic 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 (Kader

and Shanmugavelu, 1982). This pest is reported to cause 70 per cent loss under poor management conditions (Ragumoorthi and Arugum, 1992).

Butani and Verma (1981) 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 (Radovich, 2009).

Similarly, Ojiako *et al.* (2012) 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*. (2014) 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.

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

Sl. No	Common Name	Scientific Name	Family and Order	Alternate host	Reference
A	**Borers/Internal feeders**				
1.	Pod fly	*Gitona distigma* (Meigen)	Drosophilidae: Diptera	_	Meigen (1830), Ragumoorthi and Subba Roa (1997), Math and Kotikal (2014)
2.	Pod fly	*Gitona* sp.	Drosophilidae: Diptera	_	Shivagami and David (1968), Kareem *et al.* (1974), David and Kumarswamy (1975), Butani and Verma (1981) and Honnalingappa (2001)
3.	Shoot fly	*Atherigona* sp.	Muscidae: Diptera	Sorghum	Math and Kotikal (2014)
4.	Bud borers/ budworm	*Noorda moringae* Tams	Crambidae: Lepidoptera	_	Cherian and Basheer (1939), Nair (1970),

					Butani and Verma (1981), Butani and Jotwani (1984), David (2001) and Honnalingappa (2001), Math and Kotikal (2014)
5.	Fruit feeders	*Oxycetonia versicolor* Fb.	Scarabaeidae: Coleoptera	_	Butani and Verma (1981), Anjaneyamurthy (1985) and Honnalingappa (2001)
6.	Fruit fly	*Diarrhegma modestum* (Fabricius))	Diptera: Tephritidae		Hancock and Drew (1994), Hossain and Khan (2013)
7.	Bud worm/ Leaf eating caterpillar	*Protrigonia zizanialis* Swinhoe	Crambidae: Lepidoptera	_	Nair (1970), Butani and Jotwani (1984) and Honnalingappa (2001)
8.	Bud midge	*Stictodiplosus moringae* Mani	Cecidomyiidae: Diptera	_	Cherian and Basheer (1938) and Grover (1966)
9.	Cut worm/fruit borer/shoot borer	*Helicoverpa armigera* Hubner	Noctuidae: Lepidoptera	Brinjal, Okra, Chilli, Bittergourd and Onion.	Shivagami and David (1968), Butani and Jotwani (1984), Gupta (1990), Dahiya and Chauhan (1992)
10.	Cut worm	*Spodoptera litura* (Fab.)	Noctuidae: Lepidoptera	Amaranthus, Cowpea and Garden pea	Bhasin and Roonwala (1954) and Honnalingappa (2001)
11.	Bark borer	*Indarbela tetraonis* (Moore)	Indarbelidae: Lepidoptera	*Albizia lebbeck* Benth *and Casurina equisetifola* Forsti	Butani and Verma (1981), Butani and Jotwani (1984), Gupta (1990) and David (2001)
12.	Bark borer	*Indarbela* spp.	Metarbelidae: Lepidoptera	-	Math and Kotikal (2014)

13.	Stem borer	*Indarbela quadrinotata* Walker	Indarbelidae: Lepidoptera	Mango, Guava citrus, Jujube, Cashew and Litchi	Verma and Khurana (1974) and Ali *et al.* (2007)
B	**Defoliators**				
14.	Leaf eating caterpillars	*Noorda blitealis* Walker	Crambidae: Lepidoptera	_	Cherian and Basheer (1939), Nair (1970), David and Kumarswamy (1975), Lal (1975), Butani and Verma (1981), Butani and Jotwani (1984), David (2001) and Honnalingappa (2001), Math and Kotikal (2014)
15.	Hairy caterpillars	*Eupterote mollifera* Walker	Eupterotidae: Lepidoptera	*Acacia arabica,* Tamarind and Nerium	Fletcher (1914), Nair (1970), Butani and Verma (1981), Butani and Jotwani (1984) and Honnalingappa (2001)
16.	Hairy caterpillars	*Eupterote geminata* Walker	Eupterotidae: Lepidoptera	_	Butani and Verma (1981), Butani and Jotwani (1984)
17.	Hairy caterpillars	*Metanastria hyrtaca* (Cramer)	Lasiocampidae: Lepidoptera	*Mimus elengi*, *Terminalia catapa, Nyctanthus arbortristisia*, Sapota, Guava, *Eugenia* and *Acacia arabica.*	Fletcher (1914), Butani and Jotwani (1984) and David (2001)
18.	Hairy caterpillar	Undetermined	Lymantridae: Lepidoptera	-	Math and Kotikal (2014)
19.	Tussock caterpillars	*Euproctis lunata* (Walker)	Lymantridae: Lepidoptera	Cotton, *Acacia Arabica,* Tamrind, Nerium and Chrysanthemum	Honnalingappa (2001), Subramanian and Krishnamurthy (2002)
20.	Wooly bear moth/ Tiger moth	*Pericallia ricini* (Fabricius)	Arctiidae: Lepidoptera	Elephant foot yam, banana, *Coccinia*, Brinjal, Cowpea, sweet potato,	Fletcher (1914), Nair (1970), Butani and Verma (1981),

				Radish, Arum and Pumpkin.	Butani and Jotwani (1984), David (2001) and Honnalingappa (2001)
21.	Tiger moth	*Amata passalis* Fabricius	Erebidae: Lepidoptera	-	Math and Kotikal (2014)
22.	Hairy caterpillars	*Taragama siva* Lef	Lasiocampidae: Lepidoptera	*Acacia arabica*, Rose, *Polyalthia longifolia*, *Tamarix gallica*	Fletcher (1919), Sivagami and David (1968)
23.	Miner-cum webber	*Protrigonia zizanialis* Swinhoe	Pyraustidae: Lepidoptera	_	Aiyar (1945) and Honnalingappa (2001)
24.	Leaf eating caterpillar	*Actias selene* Hubner	Saturniidae: Lepidoptera	_	Fletcher (1914), Butani and Jotwani (1984) and David (2001)
25	Leaf eating caterpillar	*Ascotis selenaria imparata* Walk.	Geometridae :Lepidoptera	-	Kulkarni *et al.* (1996)
26	Leaf feeding caterpillar	*Ulopeza phaeothoracica* Hampson	Lepidoptera: Crambidae	-	Yusuf and Yusifi, 2014
27.	Painted Grasshopper	*Poekilocerus pictus* Fab.	Pyrgomorphidae: :Orthoptera	_	Honnalingappa (2001)
28.	Grass hoppers	*Chrotogonus* sp.	Pyrgomorphidae: Orthoptera		Math and Kotikal (2014)
29.	Grass hoppers	*Atractomorpha crenulata crenulata* (Fabricius)	Pyrgomorphidae: Orthoptera		Math and Kotikal (2014)
30.	Grass hoppers	*Pyrgomorpha bispinosa bispinosa* (Walker)	Pyrgomorphidae: Orthoptera		Math and Kotikal (2014)
C	**Sucking insects/ Sap feeders**				
31.	Aphids	*Aphis craccivora* Koach	Aphididae: Hemiptera	Lab lab, Ground nut, Cluster bean, Gliricidia,*Gynadropsis pentaphylla, Indigofera* sp. and *Sesbenia grandiflora* Bogdon	David (1958) and Honnalingappa (2001), Math and Kotikal (2014)
32	Cotton	*Aphis gossypii*	Aphididae	Cotton	David and

.	Aphid	Glover	:Homoptera		Kumarswamy (1975), USha Rani (2010)
33.	White fly	*Trialeurodes rara* Singh	Aleyrodidae: Hemiptera	_	Butani and Verma (1981)
34.	White fly	*Aleurodicus dispersus* Russel	Aleyrodidae: Hemiptera	_	Muralikrishna (1999) and Honnalingappa (2001)
35.	Whitefly	Undetermined	Aleyrodidae: Hemiptera	-	Math and Kotikal (2014)
36.	Scale insect	*Ceroplastodes cajani* Marshell	Coccidae: Hemiptera	Redgram, lab lab,*Zizyphus*, *Tephrosia candida* (Roxb), Coleus and *Ocimum sanctum* Linn.	Ayyar (1929),David (1958), Sivagami and David (1968), Butani and Verma (1981)
37.	Hard scale	*Diaspidiotus* sp.	Diaspididae: Homoptera	_	Ayyar (1929), Butani and Verma (1981)
38.	Thrips	*Ramaswamiahiella subnudula* Karny	Thripdae : Thysonoptra	_	Butani and Verma (1981) and Honnalingappa (2001)
39.	Flower thrips	*Thrips tabaci*	Thripidae: Thysonoptera	*Ziziphus mauritiana, Parkinsonia, aculeate* and *Cassia siamea*	Murugesan and Kumar (1996)
40.	Flower thrips	*Megalurothrips distalis* Karny	Thripidae: Thysonoptera	*Ziziphus mauritiana* Lam., *Parkinsonia, aculeate* and *Cassia siamea*	Murugesan and Kumar (1996)
41.	Flower thrips	Undetermined	Thripidae: Thysonoptera	-	Math and Kotikal (2014)
42.	Pentatomid bug	*Cyclopelta succifolia* Westwood	Pentatomodae: Homoptera	_	Butani and Verma (1981)
43.	Tea mosquito bug	*Helopeltis antonii* (Sign)	Miridae: Hemiptera	Tea, Cashew, Guava and Grapevine	Pillai *et al.* (1979) and Honnalingappa (2001)
44.	Green bug	*Nezara viridula* Linn.	Pentatomidae: Hemiptera	_	Honnalingappa (2001)
45.	Red cotton bug	*Dysdercus similis* Freeman	Pyrrhocoridae: Hemiptera)	Cotton	Honnalingappa (2001) and Math and Kotikal (2014)
46.	Tree hoppers	*Leptocentrus* sp.	Membracidae: Hemiptera	_	Honnalingappa (2001)

47.	Tree hoppers	*Otinotus* sp.	Membracidae: Hemiptera	_	Math and Kotikal (2014)
48.	True bugs	*Spilosthethus pandrurus* (Scopoli)	Lygaeidae: Hemiptera	_	Math and Kotikal (2014)
49.	Red bug	*Leptocoris* sp.	Rhopalidae: Hemiptera	_	Math and Kotikal (2014)
50.	Dusky cotton bug	*Oxycarenus hyalinipennis* (Costa)	Lygaeidae: Hemiptera	_	Math and Kotikal (2014)
51.	Painted bug	*Halyomorpha picus* (Fabricius)	Pentatomidae: Hemiptera	_	Math and Kotikal (2014)
52.	Jewel bug	*Chrysocoris stolli* Wolf	Scutelleridae: Hemiptera	_	Math and Kotikal (2014)
D.	**Beetles and Weevils/Stem borers/Bark feeders**				
53.	Longhorn beetle	*Batocera rubus* (Linnaeus)	Cerambycidae: Coleoptera	_	Subramaniam (1965), Buani and Verma (1981), Regupathy *et al.* (1989) and Honnalingappa (2001)
54.	Stem borer	*Coptops aedificator* (Fabricius)	Cerambycidae: Coleoptera	_	Butani and Verma (1981)
55.	Stem borer	*Monohammus* spp.	Cerambycidae: Coleoptera	_	Subramaniam (1965), Butani and Verma (1981)
56.	Stem borer	*Diaxenopsis apomecynoide* (Bruning)	Cerambycida : Coleoptera	_	Subramaniam (1919), Butani and Verma (1981), Sivagami and David (1968)
57.	Stem Girdler	*Sthenias grisator* (Fabricius)	Cerambycidae: Coleoptera	Grape	Math and Kotikal (2014)
58.	Flower beetle/ flower chaffer beetle	*Gametes versicolor* (Fabricius)	Scarabaeidae: Coleoptera	_	Math and Kotikal (2014)
59.	Chaffer Beetle	*Protaetia peregrina* (Herbst)	Scarabaeidae: Coleoptera	_	Math and Kotikal (2014)
60.	Chaffer Beetle	*Protaetia alboguttata* Vigors	Scarabaeidae: Coleoptera	_	Math and Kotikal (2014)
61.	Blister beetle	*Zonabris pustulata* Thunb	Meloidae: Coleoptera	_	Math and Kotikal (2014)

62.	White grub	*Holotrichia insularis* Brenske	Scarabaeidae: Coleoptera	_	Srivastava and Khan (1963), Butani and Verma (1981)
63.	Ash weevil	*Myllocerus viridanus* (Fab.)	Curculionidae: Coleoptera	_	Subramniam (1965), Butani and Verma (1981) and Honnalingappa (2001), Math and Kotikal (2014)
64.	Ash weevil	*Myllocerus teniclavis var. inferior* Marshell	Curculionidae: Coleoptera	_	Subramaniam (1965), Butani and Verma (1981)
65.	Ash weevil	*Myllocerus 11-pustulatus* Fst	Curculionidae: Coleoptera	Cotton, Castor, Cholam and Bhendi	Subramaniam (1965)
66.	Ash weevil	*Myllocerus discolor var. variegates* Boheman	Curculionidae: Coleoptera	Cholam, Maize, cotton, Redgram and Guava	Subramaniam (1965) and Honnalingappa (2001), Math and Kotikal (2014)
67.	Ash weevil	*Ptochus ovulum* Fst.	Curculionidae: Coleoptera	Amaranthus, Beet root, Bhendi, *Gliricidia maculata*	Subramaniam (1965)
68.	Ash weevil	*Myllocerus delicatulus* Boheman	Curculionidae: Coleoptera	_	Honnalingappa (2001)
69.	Weevil	*Ptochus ovulum* Fst.	Curculionidae: Coleoptera	Amaranthus, Beet root, bhendi, *Gliricidia maculata* and Millingtonia	Subramaniam (1965)
70.	Ash weevils	*Myllocerus* sp.	Curculionidae Coleoptera	_	Math and Kotikal (2014)
71.	Beetle grub	*Holotrichia reynaudi* Blanchard	Melolonthidae: Coleoptera	_	Srivastava and Khan (1963)
72.	Termite	*Microtermes* spp.	Kalotermitidae: Isoptera	_	Ali and Chaturvedi (1996)
73.	Termite	*Odontotermes* sp.	Kalotermitidae: Isoptera	_	Ali and Chaturvedi (1996)
E	**Non insect pests**				
1.	Mites	*Tetranychus neocaledonicus* (Andre)	Tetranychidae: Acarina	_	Banu and Channabasavanna (1972), Sangeetha and Ramani (2007)
2.	Mite	*Aculus menoni*	Eriophyidae:	_	Butani and

		Channabasavanna	Acarina		Verma (1981)
3.	Mite	*A. Moringae* Channa basavanna	Eriophyidae: Acarina	_	Butani and Verma (1981), Mohansundaram (1985) and Honnalingappa (2001)
4.	Mite	*A. pterigospermae* Keifer	Eriophyidae: Acarina	_	Mohansundaram (1985) and Honnalingappa (2001)
5.	Land snails and tree	*Achatina* sp. and *Helix* sp.	(Mollusca: Gastropoda)	_	Okonkwo *et al*. (2014)

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, Math and Kotikal (2014) 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 *Myllocerus* 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.

A. 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 (Subramaniam, 1919). 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 (Parrotta, 2009).

Ali *et al.* (2007) 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 lebbeck*, *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 gallaries and later bore inside bark or main stem, remain within these burrows during day but come out at night and feed on bark (Usha Rani *et al*., 2010).

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 (Usha Rani *et al*., 2010).

Diarrhegma 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 (Hancock and Drew, 1994). For the first time the occurrence of *D. modestum* (Fabricius) was reported from Bangladesh (Hossain and Khan 2013).

The pod fly, *Gitona distigma* (Meigen), a palaearctic species reported for the first time in India (Ragumoorthi and Subba Rao, 1997) has attained a major pest status in Southern India (Kader and Shanmugavelu, 1982). It is reported to cause 70 per cent loss under poor management conditions (Ragumoorthi and Arumugam, 1992). Economic injury level (EIL) for this pest is 15 per cent of affected fruits (Ragumoorthi *et al*., 1998). 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 (Honnalingappa, 2001).

Recently, Math and Kotikal (2014) 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 (Usha Rani *et al*., 2010). Usha Rani *et al*. (2010) 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 (Math and Kotikal, 2014).

B. Defoliators/ Leaf feeders

Butani and Verma (1981) 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 (David and Kumarswamy, 1982). The leaf caterpillar, *N. blitealis* Walker was seasonal and found to occur during January to April in Periyakulam, Tamil Nadu (Anjaneyamurthy, 1985).

Munj *et al.* (1998) 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. Subramanian and Krishnamurthy (2002) 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.* (2013) 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.

Math and Kotikal (2014) 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, (2014) 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. Math and Kotikal (2014) 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.

C. 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 (Ayyar, 1929), Aphids, *Aphis craccivora* Koach, have been observed to infest the tender shoots of moringa during January to March on the under surface of leaflets (David, 1958).

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, *Ramaswamiahiella subnudula* Karmy, a polyphagus pest has also found to feeding and breeding in inflorescence of drumstick (Butani and Verma, 1981).

Scale, *Ceroplastodes cajani* both nymps and adults suck the sap and affect the vigour of the plants. Though each insect takes only 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 (Usha Rani *et al*., 2010).

Palada and Chang (2003) and Radovich (2009) 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 Radovich (2009) 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 Okonkwo *et al*. (2014). Palada and Chang (2003) 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 (Usha Rani *et al*., 2010). 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 (Math and Kotikal, 2014).

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) (Math and Kotikal, 2014).

D. 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 (Butani and Verma, 1981). From Rajsthan, 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 mansoon showers, when they come out at night and feed voraciously on foliage (Srivastav and Khan, 1963). Usha Rani *et al*. (2010) reported white grubs feeds on roots and adult beetles feeds on leaves. Adults come out with mansoon during June-July.

Subramaniam (1965) observed the five species of weevils Mylloceros 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, finelly consuming the entire leaf balde.

The adult weevils cause notching of leaves. Grubs feeds on roots and causes wilting of plants (Usha Rani *et al*., 2010). Three species of Ash weevils, *Myllocerus viridanus* Fabricius,

Myllocerus discolor (Boheman) and *Myllocerus* sp., were recorded by Math and Kotikal (2014) on drumstick. *Myllocerus viridanus* is a small weevil having uniform pale greenish white scaling on the body, which often exhibits chalky whit e 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. *Myllocerus 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 *Myllocerus* were observed to damage drumstick in the month of July to December with an average of population of 6 adult weevils per branch.

E. 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 (Puttaswamy and Reddy, 1980). 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 (Palada and Chang 2003).

Sangeetha and Ramani (2007) 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. *Aculus menoni* Channa Basavanna, (1966) mites are vagrants on both the surfaces of leaves causing no apparent damage symptoms to its host. *Aculus moringeae* Channa Basavanna (1966) 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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