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Composition, Distribution and Economic Importance of Insect Pests of Prioritized Medicinal Plants in Some Growing of Ethiopia

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Abstract – Ethiopia is remarkably rich in its biological, ecological and landscape diversity and is home to outstanding natural bio-resources of medicinal plants. The present study was carried out to study the composition, distribution and economic importance of insect pests of prioritized medicinal (chamomile, kebericho, sage stevia, artemisia, senna, ariti, African marigold and hibiscus) plants between 2013 to 2015 in some growing area of Ethiopia. 10 to 20 random sample units (plants) were taken to assess pest prevalence from each of the upper, middle and lower canopy layers of the main stem. Sample pests and infected plant parts were taken and examined in Wondo Genet Agricultural Research Center. *Agrotis* sp., *Aphis fabae, Aphis* sp., *Dysdercus* sp., *Earias biplaga, Lipaphis* sp., *Lipaphis* sp., *Nipaecoccus viridis* and *Ornithacris* sp. were the major insect pests of medicinal plants where as *Dicyphus* spp., *Euxoa scandens, Ferrisia virgata, Odontotermes* spp., *Sphaerocoris annulus,* and *Aphis gossypii* were minor insect pests recorded feeding the medicinal plants. In all 14 insect species belonging to 4 orders were recorded to be associated with (8) medicinal plants in the survey area of Ethiopia. All these insect-pests were recorded in very low to very high causing damage. This study important for understanding the situation of medicinal insect pests that will help to eventually achieve an economically sound and efficient pests management strategy.

Keywords **– Insect-pests, Prioritized Medicinal Plants, Infestation and Damage Level.**

I. INTRODUCTION

Globally aromatic and medicinal plant species are ranged from 35,000-50,000 in number and out of this 4,000-6,000 species have entered the world market of medicinal plants and about 100 species have been used as a source of modern drugs [1]. According to the definition of WHO**,** medicinal plant is part of the larger category of plants "herbs" and is a plant organism that contains, in one of its organs, substances that can be used in therapy, or which are precursors of hemi synthesis of pharmaceutical species [2].

In Ethiopia, it is reported that 70-80% of the population [3] and 80-90% of the animals [4] uses traditional herbal medicine for their health care system due to the cultural acceptability of healers and local pharmacopoeias, the relatively low cost of traditional medicine and difficult access to modern health facilities [3]. On the other side, the value of both imported and domestically produced pharmaceutical products were reported to be about 1.05 billion ETB in 2007 [4] and other reports indicated that Ethiopia spends more than 8 billion ETB for importation of modern medicines currently.

The traditional health care in Ethiopia is culturally deep rooted with oral and written pharmacopoeias [4]. Use of traditional medicine for treatment of ailments is by large demanded by the majority of the population for some reasons such as, culturally linked traditions, the thrust the communities have in the medicinal values of traditional medicine and relatively low costs they have [4]. Of the existing medicinal herbs and spice plants only small percents are traded. As indicated by the same author, being a land of diverse climatic and edaphic potentials, several of such indigenous and exotic species and essential oil bearing plants could luxuriously grow in Ethiopia and provide remarkable benefits to the national economy.

However, like agricultural crops various constraints pose serious problem for cultivation of medicinal plants viz. nutrient management, water management, suitable genotype, agro-climatic condition, insect pests, and diseases and weed management. Therefore, to obtain large quantity of good quality of medicinal plants, not only high yielding varieties are to be involved and grown under optimum agronomical conditions, they require to be protected from diseases and pests [5]. It is thus, very imperative to identify and protect the plants from different insect pests to derive maximum benefit from medicinal plants. The information regarding the occurrence and economic importance of insect-pests on medicinal plants of the country is scanty. So to design effective controlling strategy for these biotic stresses, identification and distribution of major insect pests of medicinal plants is found essential. Therefore, the objective of this study was to identify composition**,** distribution and determination of economic importance of insect pests of prioritized medicinal (chamomile, kebericho, sage stevia, artemisia, senna, ariti, African marigold and hibiscus) plants**.**

II. MATERIALS AND METHODS

The survey was carried out at Wondo Genet, Hawasa, Alagae, Koka, Dabra Zait, Managasha and Hollata stations from 2013 to 2015 at vegetative and maturity growth stages of medicinal plants. In these locations the plants grown for the purpose of different research and private for commercial (Hawasa Green Mark Herbs PLC.). List of prioritized medicinal plants selected for insect pests survey was showed as follows. Chamomile (*Matricaria chamomile* L.), kebericho (*Echnopis kebericho),* stevia *(Stevia rebaudiana* Bertoni L), artemisia (*Artemisia anua* L.), hibiscus (*Hibiscus subdariffa),* ariti *(Artemisia rehan),* senna *(Senna alexanderiana)* and sage *(Salvia officinalis*

L) were the major medicinal plants that focused insect pest survey take place.

Description of the Study Areas

Table 1. Site description of insect pests survey areas in Ethiopia

Survey area	Latitude	Longitude	Soil PH	Soil types	Rain fall (mm)	Altitude (m.a.sl)	Annual average temperature (^{0} C)	
							Minimum	Maximum
Wondo Genet	7^0 192' N	38^0 382' E	6.4	Sandy clay loam (Nitosol)	1000	1876	12.02	26.72
Hawasa	7^0 05' N	$39^0$29' E	7.2	Sandy loam (Andosol)	964	1652	12.94	27.34
Koka	8^0 26'N	39^0 1' E	-	Clay soil	830.9	1604	13.68	28.30
Hollata	$9^0$03'N	38^0 30'N		Red brown clay loam soil	1100	2390	6.13	22.2

Source: Beemnet *et al.*, 2010

Depending upon the availability of plants 10 to 20 random sample units (plants) were taken to assess pest prevalence from each of the upper, middle and lower canopy layers of the main stem. Moreover, sample infested plant parts and insect pests were collected from the same selected sampling fields and brought to Wondo Genet Agriculture Center plant protection laboratory for further identification of insect pests. During survey, necessary information on damaging stage of the pest, weather condition, plant age or stage, etc, were collected critically. Identifications processes were done in collaboration with Ambo Plant Protection and Addis Ababa University. And also the species were later on got identified from different sources. The insect damage scale was assigned according to [6] that states very low (≤5%), low (6-10%), medium (11-20%), high (21-50%) and very high (>50%) levels. Data such as number of infested plants versus total number plants, damaged plant parts versus total area of plant tissue were recorded to determine percent incidence (infestation) and severity (damaged level). Incidence and severity of pests from the attacked plants, was calculated by using the following formula.

$$Per\ cent\ infestetation = \frac{Number\ of\ infested\ plants}{Total\ number\ of observed\ plant} \times 100$$

$$Damage\ level = \frac{Area\ of\ plant\ tissues\ infested\ by\ pest}{Total\ area\ of\ plant\ (tissue)} \times 100$$

III. Results and Discussions

Composition, Distribution and Economic Importance of Insect Pests

The present survey revealed distribution, composition and economic importance of insect pests of prioritized medicinal plants in some parts growing area of Ethiopia between 2013 and 2015 (Table 2). In all 14 insect species belonging to 4 orders were recorded to be associated with (8) medicinal plants in the survey area of Ethiopia. All these pests were recorded in very low to very high infestation rate and causing low to moderate damage level. The information recorded with respect to incidence of different insect pests on different medicinal plants during survey study was given in Table 2. These are being discussed plant-wise as follows:

Insect Pests Associated with Artemisia

Artemisia (*Artemisia annua* L.) is an aromatic herb widely distributed in the cool temperate and subtropical regions of the world. The plant has Chinese origin and a few countries like China, Kenya, the United Republic of Tanzania and Vietnam are cultivating it on a large scale [7]. Ethiopia has already started cultivation of Artemisia in Wondo Genet Agricultural Research Center and other parts of the country. The chemical composition of *A. annua* consists of volatile and nonvolatile constituents, mainly sesquiterpenoids, including artemisinins. Our survey identified that aphid (*Lipaphis* sp.) and *Earias biplaga* (Wkl.) were the major insect pests recorded feeding with 45% and 40% infestation rate, respectively and cause high damage level in wondo genet and Koka. Causing wilting of leaves and stem then death of the plant occur. Those pests distributed in entire the fields of artemisia sites. [7] reported that aphid which cause suck sap from young leaves and shoots and can be seen on lower side of leaves whereas ants attack plants mostly during seedling stage which lead to withering and complete death of the plant.

Insect Pests Associated with Hibiscus

Hibiscus (*Hibiscus sabdariffa* L.) belongs to the family Malvaceae, locally called "karkade", is an important annual crop grown successfully in tropical and sub-tropical climates [8]. It grows in Ethiopia and the commercially important part of the plant is the fleshy calyx (sepals) surrounding the fruit (capsules). The whole plant can be used as beverage, or the dried calyces can be soaked in water to prepare a colorful cold drink, or may be boiled in water and taken as a hot drink. It also has some medicinal properties [9]. Hibiscus mealybug (*Nipaecoccus viridis* (Newstead) and Stainer bugs (*Dysdercus* sp.) were the major insect pests recorded feeding hibiscus whereas striped mealy bug (*Ferrisia virgata* (Ckll.), picasso bug (*Sphaerocoris annulus*) and black aphids (*Aphis gossypii* Glover) were the minor insect pest recorded from the hibiscus during survey time (Fig. 1a). They were causing low to high damaging on leaves and stem that can affect photosynthesis of the plant causing low production and

quality of the plant product. According to [10] *Anomis erosa, Chaetocnema sp., Cosmophila erosa, Dysdercus cingulatus, D. poecilus, Drosicha townsendi, Nistora gemella, Phenacoccus hirsutus, Pseudococcus filamentosus and Tectocoris diophthalmus* were the mojar insect pests attacks *H. sabdariffa* L. plant that differ from our findings. The difference may due to different agro ecology of Ethiopia from study area.

Insect Pests Associated with Ariti

Black aphid (*Lipaphis* sp.) was the major insect pest recording feeding of *Artemisia rehan.* Black aphid was causing very high damage level with 60% infestation rate in Wondo Genet (Fig. 1c). The pest damage leaves and stem and distributed randomly in the field of cultivated sites. There is no report on the occurrence of insect pest on *A. rehan* in literature.

Insect Pests Associated with Senna

Senna is found in many tropical countries including in our country. The plant has been used in India for thousands of years as a laxative. It can be found in capsule and tablet form, tea bags and loose tea, as well as liquid extracts. Both leaves and pods of the senna plant are used for their laxative effects. The pods are less potent than the leaves [11]. Worm (*Euxoa scandens* (Riley) was minor insect pest recorded on senna (*Senna alexanderiana*) with 9% infestation rate and low damage level in Wondo Genet and rondamily distributed in the site. There is no report on the occurrence of insect pest on senna in literature.

Insect Pests Associated with Sage

Sage (*Salvia officinalis* L.) is a perennial shrub native to southern Europe and Asia [12]. It is one of the oldest medicinal plants and also has been used for a long time in folk medicine as medication against fever, rheumatism, perspiration, sexual debility, and in the treatment of chronic bronchitis, as well as mental and nervous diseases [13]. Now in Ethiopia the production of sage is not well recognized and has got little consideration to undertake the production for commercial purpose. However, our center produces for research and demonstration purpose. The minor insect pests' termite (*Odontotermes* sp) with 8% infestation rate in Koka and plant bug (*Dicyphus* sp.) with 5% infestation rate in wondo genet was recorded from feeding sage. Different reports were indicated that many insect pests infested and damage sage. According to [14] indicated the armyworm *Phytometra chrysitis* as a sage pest, while [15] indicated the caterpillar *Zygaena punctum* as causing damage to sage leaves. [16] report that sage flowers were infested with *Zygaena punctum, Adelphocoris lineolatus, Euridema ornata* and *Dolicoris baccarum* while *Disaneura salviae, Thrips tabaci, Empoasca pteridis, Aceria salvia* and *Tetranychus lubeniu* were found on the leaves.

Insect Pests Associated with Chamomile

Chamomile (*Matricaria chamomilla* L.) is a well-known medicinal plant species from the Asteraceae family often referred to as the "star among medicinal species." Nowadays it is a highly favored and much used medicinal plant in folk and traditional medicine. Its multi therapeutic, cosmetic, and nutritional values have been established through years of traditional and scientific use and research [17]. It is planted in Ethiopia traditionally in farmer garden as well as in Wondo Genet Agricultural research Center for research purpose. Black bean aphid (*Aphis fabae*) with 25% infestation rate in Wondo Genet was major insect pest identified from the chamomile. The pest caused shedding of flowers, leaves and feeds the phloem stem and distributed in the entire field in the cultivated field (Fig. 1d). [18] reported that black bean aphids (*Aphis fabae*) were feeding on *M. chamomilla* that similar with our findings whereas [19] reported that the insect *Nysius minor* caused shedding of flowers and *Autographa chryson* causes defoliation of *M. chamomilla* plant that differ from our study.

Insect Pests Associated with Kebericho

Kebericho *(Echinops kebericho),* endemic to Ethiopia, is a critically endangered medicinal plant. It is among the most important medicinal plants of the country, valued primarily for its root parts. The commercial harvesting and sale of roots of kebericho have threatened local populations. During survey time insect pest of cut worm (*Agrotis* sp.) with 25 % infestation level and high damage level; black aphids (*Aphis* sp.) with 40% infestation level and medium damage level in Wondo Genet and Hawassa were identified (Fig. 1b). Black aphids was major pest causing leaves and stem damage and distributed all entered field of the kebericho site where as were affect leaves and randomly distributed in the fields. In future black aphids and cut worms may be important pests of kebericho in the Ethiopia. There is no report on the occurrence of insect pest on kebericho in literature.

Insect Pests Associated with Stevia

Stevia rebaudiana Bertoni is a branched bushy shrub of the Asteraceae family, native to the Amambay region in the north east of Paraguay. It also occurs in the neighbouring parts of Brazil and Argentina [20]. Today its cultivation has spread to other regions of the world, including Canada and some parts of Asia and Europe [21] and [22]. Presently, *Stevia* is well-known for its high content of sweet diterpene (about 4–20%) in dry-leaf matter [23]. It is the source of a number of sweet *ent*-kaurene diterpenoid glycosides [24] and the stevia glycosides are the compounds responsible for the sweet taste. Among the 230 species in the genus *Stevia,* only the pecies *rebaudiana* and *phlebophylla* produce steviol glycosides [25]. *S. rebaudiana* is planted in Ethiopia traditionally in farmer garden and commercially production purpose as well as in Wondo Genet Agricultural research Center for research purpose. During survey, Grasshopper (*Ornithacris* sp.) was the major insect pest recorded feeding of stevia with 10% infestation rate and low damage level in Wondo Genet. The grasshopper pest affects the leaves and randomly distributed in the field of the stevia. [26] reported that thrips, aphids, cutworms, whitefly, slugs and snails and gophers are the major insect pests of stevia (http://www.smartgardener.com/plants/2078-stevia-stevia/pests) that was differ from our findings. This may due to different agro ecology of our country from the others.

Insect Pests Associated with African marigold

Cut worm (*Agrotis* sp.) was minor insect pest infested African marigold (*Tagetes erecta*) in wondo genet. There is no report on the occurrence of insect pest on african marigold in literature.

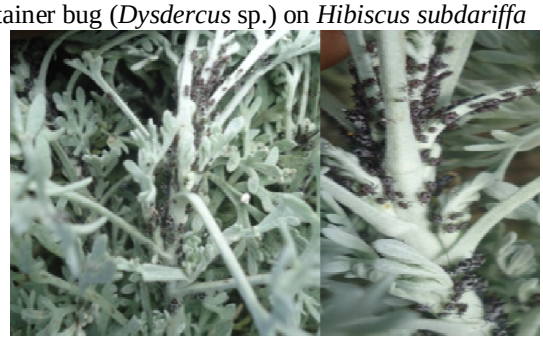
Table 2. Distribution, composition and damage extent of insect of insect pests of prioritized medicinal plants between 2013-2015 in some growing of Ethiopia

Hosts	Sites	Insect Pests				Plant part damage	Distributions	Infestation (%)	Damage level (%)
		Common name	Order	Family	Scientific name				
Matricaria chamomile L.	Wondo Genet	Black bean aphid	Hemiptera	Aphididae	*Aphis fabae****	Leaves and stem	entire field	25	20
Echnopis kebericho	Wondo Genet	cut worm	Lepidoptera	Noctuidae	*Agrotis* sp.***	Leaves	randomly	25	15
	Wondo Genet and Hawassa	Black Aphids	Hemiptera	Aphididae	*Aphis* sp.*****	Leaves and stem	entire field	40	25
Stevia rebaudiana Bertoni L	Wondo Genet	Grasshopper	Orthoptera	Acrididae	*Ornithacris* sp.***	Leaves	randomly	10	15
Artemisia anua L.	Wondo Genet	Aphid	Hemiptera	Aphididae	*Lipaphis* sp.*****	Leaves and stem	entire field	45	25
	Wondo Genet & Koka	Spiny boll worm	Lepidoptera	Noctuidae	*Earias biplaga* (Wkl.)*****	Leaves and stem	entire field	40	35
Hibiscus subdariffa	Wondo Genet and koka	Stainer bugs	Hemiptera	Pseudococcidae	*Dysdercus* sp.*****	Leaves	entire field	45	35
		Striped mealy bug	Hemiptera	Pseudococcidae	*Ferrisia virgata* (Ckll.)*	Leaves	randomly	6	3
		hibiscus mealybug	Hemiptera	Pseudococcidae	*Nipaecoccus viridis* (Newstead) *****	Leaves	entire field	50	30
		Picasso bug	Hemiptera	Scutelleridae	*Sphaerocoris annulus***	Leaves	randomly	12	6
		Black Aphids	Hemiptera	Aphididae	*Aphis gossypii* Glover**	Leaves	randomly	10	6
Artemisia rehan	Wondo Genet	Black Aphid	Hemiptera	Aphididae	*Lipaphis* sp.*****	Leaves and stem	randomly	60	35
Senna alexanderiana	*Wondo Genet*	worm	Lepidoptera	Noctuidae	*Euxoa scandens* (Riley)*	Leaves	randomly	9	4
Salvia officinalis L	koka	Termite	Isoptera	Termitidae	*Odontotermes* spp.*	Leaves, stem and root	randomly	8	5
	Wondo Genet	Plant bug	Hemiptera	Miridae	*Dicyphus* spp.*	Leaves and stem	randomly	5	2

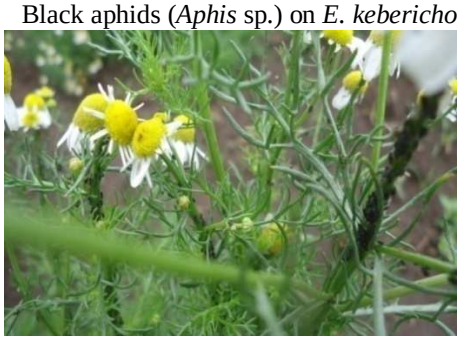
Wondo Genet, Hawasa, Koka, Hollata, Debra Zeit and Managasha

a. Stainer bug (*Dysdercus* sp.) on *Hibiscus subdariffa*

b. Black aphids (*Aphis* sp.) on *E. kebericho*



c. Balck aphids (*Lipaphis* sp.) on *Artemisia rehan*



d. Aphids (*Aphis fabae)* on *Matricaria chamomile* L.

Fig. 1. Insect-pests associated with medicinal plants in some growing area in Ethiopia

IV. Conclusion and Recommendation

The present study provided some clues to the understanding of the distribution, composition and economic importance of insect pests of prioritized medicinal plants in Ethiopia. From this study it can be concluded that *Agrotis* sp., *Aphis fabae*, *Aphis* sp., *Dysdercus* sp., *Earias biplaga*, *Lipaphis* sp., *Lipaphis* sp., *Nipaecoccus viridis* and *Ornithacris* sp. were the major insect pests of medicinal plants where as *Dicyphus* spp., *Euxoa scandens*, *Ferrisia virgata*, *Odontotermes* spp., *Sphaerocoris annulus*, and *Aphis gossypii* were minor insect pests recorded feeding medicinal plants. Understanding the situation of medicinal insect pests will help to eventually achieve an economically sound and efficient pests management strategy. Future research emphasis should be given due concern for the development of integrated/appropriate pest management strategies for economically important insect pests of medicinal plants for higher production and productivity. The major medicinal plants growing areas of other parts of Ethiopia should be surveyed as the current survey is not inclusive of all areas due to logistic problem. Periodic survey should be carried out to monitor the pest's status as production system and environmental conditions are dynamic to regulate pest population and their economic importance. At this stage the economic status of various species is not well defined and the corresponding thresholds are not worked out. Since those crops has attained high importance as supplement to produce valuable substances, pharmaceutical and cosmetic industries. It is necessary to develop cost effective pest management practices with environmental concern.

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