



Identification and Determination of Economic Importance of Insect Pests and Diseases of Nonedible oil-bearing Plants in Some Growing of Ethiopia

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Date of publication (dd/mm/yyyy): 12/07/2017

Abstract – Ethiopia is remarkably rich in its biological, ecological and landscape diversity and is home to outstanding natural bio-resources such as the physic nut, castor and vernonia plants. The present study was carried out to study the composition, distribution and economic importance of insect pests and diseases of non-edible oil plants between 2013 to 2016 in some growing area of Ethiopia. 10 to 20 random sample units (plants) were taken to assess insect pest and diseases prevalence from each of the upper, middle and lower canopy layers of the main stem. Sampling was done by following an inverted W-pattern within the field. Sample insect pests and diseases and infected plant parts were taken and examined in Wondo Genet Agricultural Research Center. The species were later got identified from different sources. The result showed that *Tetranychus* sp., *Liriomyza* sp., *Tribolium* sp. and *Paracoccus marginatus* were the major insect pests recorded from physic nut. *Dicyphus* sp., *Euproctis* sp., *Tetranychus* sp., *Phyllophaga* sp. and *Conogethes* sp. were major insect pests recorded from castor. *Captosoma* sp. and *Achaea* sp. were major insect pest recorded from vernonia. In all 10 insect species belonging to 6 orders were observed from non-edible oil plants at different survey area in Ethiopia. All these insect pests were recorded in very low to very high causing damage. *Pseudoidium jatrophae*, *Begomovirus* sp and *Colletotrichum* sp. were diseases recorded from physic nut. *Melampsora ricini*, *Fusarium oxysporum* and *Alternaria ricini* were diseases recorded from castor whereas *Erysiphe* sp and *Fusarium* sp were major diseases recorded from vernonia. This study important for understanding the situation of non-edible oil pests that will help to eventually achieve an economically sound and efficient insect pests and diseases management strategy.

Keywords – Insect-pests, Diseases, Non-edible Oil Bearing Plants, Infestation, Damage Level, Severity and Incidence.

I. INTRODUCTION

Ethiopia has long been known a center of origin and diversity for several plants including non- edible oil plants via. physic nut (*Jatropha curcas* L.), castor (*Ricinus communis* L.) and vernonia (*Vernonia galamensis*), which is mainly due to its wide range of climatic, ecological and topographic conditions[1]. Physic nut (*Jatropha curcas* L.) is a plant which is native of Central America and Mexico and naturalized throughout the tropics and subtropics [2], [3] and [4]. Now it is grown in the continent of Latin America, Asia and Africa including Ethiopia aiming to produce biodiesel [5]. Owing to declining petroleum reserves and the need for supplementing and replacing it, alternative renewable, non-toxic, and less polluted energy has attracted the interest of many countries [6] and [7]. In general, the interest of physic nut as a biodiesel feedstock

has increased due to environmental, energy security, economic and rural development factors.

Castor (*Ricinus communis* L.) is non edible oil-bearing plants adapted to dry lands of tropics and semi-arid tropics. The plant is believed to be native of East Africa and probably originated in Ethiopia where it shows tremendous variability. In Ethiopia, castor grows as annual in the low lands to small tree perennial in the high lands. India, china, Brazil and USA are the major castor producers globally. Castor bears seeds that containing highly valuable industrial oil. Castor oil is unique among vegetable oil because it is the only commercial source of a hydroxylated fatty acid or ricinoleic acid [8]. The hydroxyl group in ricinoleic acid is important point of chemical reaction that allows several chemical reactions. Castor oil is highly soluble in alcohol at room temperature that facilitates several chemical reactions. Castor oil has also high viscosity over a wide range of temperatures which makes it a valuable ingredient of lubricants.

Vernonia (*Vernonia galamensis*) is an annual herb that belongs to the family of Astraceae that was known to be originated in East Africa [9]. It is a new annual industrial oilseed. It grows naturally in marginal areas with as little as 200 mm seasonal rainfall and at an elevation ranging from 700–2400 m in the southern and southeastern parts of Ethiopia [10] The seed oil has unique chemical and physical properties that will permit its use in the formulation of reactive diluents, products to serve as solvents that become part of the dry paint surface and do not evaporate to pollute the air [11]. Seeds of produce triglyceride oil rich in trivernolin (35- 42%). Vernolic acid (cis-12, 13-epoxyoleic acid) composes 72 - 80% of the acids present in the seed oil [12]. A natural low-viscosity, epoxy oil is now available from vernonia seeds. Epoxy oils are important in oleo chemical industry for the manufacture of plastic formulations, protective coatings, lubricants, and other products.

The cultivation of those non edible oil- bearing expands the livelihood options with the opportunity to earn additional income for small holders, out growers and members of community plantation. Therefore, to obtain large quantity of good quality of industrials oil/non-edible oil crops, not only high yielding varieties are to be involved and grown under optimum agronomical conditions, they require to be protected from diseases and insect pests [13]. It is thus, very imperative to identify and protect the plants from different insect pests and diseases to derive maximum benefit from non-edible oil crops. The information regarding the occurrence and economic importance of insect-pests and diseases on non-edible oil plants of the



country is scanty. So to design effective controlling strategy for these biotic stresses, identification and distribution of major insect pests and diseases of non-edible oils crops is found essential. Therefore, the objective of this study was to identification and determination of economic importance of insect pests and diseases of physic nut, castor and vernonia in Ethiopia.

II. MATERIALS AND METHODS

The survey was carried out at Wondo Genet, Hawassa, Alagae, AdamiTullu, Arba minch, Goffa and Mirab Abaya

Description of the Study Areas

Table 1. Site description of insect pests and diseases 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
Hawassa	7 ⁰ 05' N	39 ⁰ 29' E	7.2	Sandy loam (Andosol)	964	1652	12.94	27.34
Allagae	7 ⁰ 43' N	38 ⁰ 36' E	8.4	Clay loam	510	1594	13.44	26.61
Koka	8 ⁰ 26' N	39 ⁰ 1' E	-	Clay soil	830.9	1604	13.68	28.30

Source: [14]

Depending upon the availability of plants 8 to 15 random sample units (plants) were taken to assess insect pests and diseases prevalence from each of the tissue were recorded to determine percent infestation and damaged level and incidence and severity of diseases from the affected plants were calculated by using the following formula.

$$\begin{aligned} \text{Per cent infestation} &= \frac{\text{Number of infested plants}}{\text{Total number of observed plant}} \times 100 \\ \text{Damage level} &= \frac{\text{Area of plant tissues infested by pest}}{\text{Total area of plant (tissue)}} \times 100 \\ \text{Disease incidence (I)} &= \frac{\text{Number of infested plant units}}{\text{Total number (healthy and infested) units assessed}} \times 100 \\ \text{Disease severity (S)} &= \frac{\text{Area of plant tissue affected by disease}}{\text{Total area of plant (tissue)}} \times 100 \end{aligned}$$

III. RESULTS AND DISCUSSIONS

The present survey revealed distribution, composition and economic importance of insect pests and diseases of non-edible oil crops in some parts growing area of Ethiopia between 2013 and 2016 (Table 2). In all 10 insect species belonging to 6 orders were recorded to be associated with physic nut (*Jatropha curcas* L.), castor (*Ricinus communis* L.) and vernonia (*Vernonia galamensis* L.) crops in the survey area of Ethiopia.

Composition, Distribution and Economic Importance of Insect Pests Associated with non-Edible Oil-bearing Crops.

and others growing areas from 2013 to 2016 at vegetative and maturity growth stages of physic nut (*Jatropha curcas* L.), castor (*Ricinus communis* L.) and vernonia (*Vernonia galamensis* L.) plants that were focused on identification and determination of economic importance of insect pests and diseases. In these locations the plants were grown for the purpose of different research, natural growing, privates and others.

IV. INSECT PESTS ASSOCIATED WITH PHYSIC NUT

Physic nut (*Jatropha curcas* L.) is attacked by several insect species of which causing considerable damage to different parts at different stages of the crop. During survey time mealybug (*Paracoccus marginatus* Williams), flour beetles (*Tribolium* sp) and blister leaf miner (*Liriomyza* sp.) were the major insect pest on physic nut causing high damage and high rate of infestation in alagae whereas spider mite (*Tetranychus* sp.) was the minor insect pest recorded in Adami Tulu (Table 2). The mealy bugs feed on leaves and fruits which results in chlorosis, yellowing, stunting, deformation, early leaf and fruit drop. Sooty mold growing on honeydew excreted by the mealy bugs interferes with photosynthesis. Heavy mealy bug infestations may kill young plants (Fig. 1a). Flour beetles (*Tribolium* sp.) was the major insect pest recorded from alagae and koka that feed leaves which results holes leave, chlorosis and early leaves drop (fig.1d). Reports indicated that leaf miner and white wooly aphid were observed to severely infest *J. curcas* at Tibila and Upper Awash [16]. According to [17] leaf webber (*Pempelia morosalis*), blister leaf miner, *Stomphastis thraustica* Meyerick, Brown soft scale (*Coccus hesperidum*. Linnaeus), mealybug (*Paracoccus marginatus* Williams), Scutellerid bug (*Scutellera nobilis* Fabr.), jewel bug (*Chrysocoris purpureus* Westw.), red spider mite, *Tetranychus* sp., yellow mite (*Polyphagotar sonemuslatus* (Banks) and termites (*Odontotermes formosanus* Shiraki) were the major insect pests of physic nu that support our findings. [18] also report that *Stomphastis thraustica* (Meyrick), *Aulacophora africana* (Weise), *Alticasp.*, *Lagriavillosa* (Fabricius), *Paracoccus marginatus* Williams and Gramara de Willink, *Denticeranr divisella* (Duponchel), *Nezara*



viridula (Linnaeus), *Calide adregei* Germar, and *Riptortus dentipes* (Fabricius) were the most important of phytophagous insect pest species recorded from physic nut.

V. INSECT PESTS ASSOCIATED WITH CASTOR

Castor (*Ricinus communis* L.) plant is attacked by several insect species of which causing considerable damage to different parts at different stages of the crop. Plant bug (*Dicyphus* sp.), hairy caterpillar (*Euproctis* sp.), red spider mite (*Tetranychus* sp), white grubs (C shape) (*Phyllophaga* sp.) and shoot borer (*Conogethes* sp.) were the major insect pests with 8-45% infestation rate and causing medium to high damage whereas moth was the

minor insect pest infested in Wondo Genet from castor during survey (Table 2). Red spider mite infested leaves first show a white to yellow speckling and then turn pale or bronzed, as the infestation becomes heavy prefer the lower surface of the leaves. Under heavy infestation the plant can be completely covered with webbing. High infestations cause defoliation, which leads to production of smaller and lighter fruits (Fig 2h). Those insect pests can be economically important which affect the growth of castor and causing damage to the plant and loss in seed and leaf yield in the survey area in Ethiopia. Similar studies conducted by [19] explained that mealy bugs (*Paracoccus* sp.), scale insects (*Aonidiella* sp. and *Coccus* sp.) semi looper (*Achoea* sp.), common bugs (*Acrosternum* sp.), jassids (*Empoasca* sp. and *Eurymela* sp.),

Table 2. Distribution, composition and damage extent of insect of insect pests of non-edible oil between 2013-2016 in some growing of Ethiopia

Hosts	Sites	Insect Pests				Plant part damage	Distributions	Infestation (%)	Damage level (%)
		Common name	Order	Family	Scientific name				
<i>Jatropha curcas</i> L.	Alagea, Koka, Adami tulu, Arbaminch	Spider mite	Acarina	Tetranychidae	<i>Tetranychus</i> sp.**	Leaves	randomly	10	6
		Blister leaf miner	Diptera	Agromyzidae	<i>Liriomyza</i> sp.***	Leaves	randomly	23	13
		flour beetle	Coleoptera	Tenebrionidae	<i>Tribolium</i> sp.***	Leaves	entire field	85	65
		Mealybug	Homoptera	Pseudococcidae	<i>Paracoccus marginatus</i> Williams***	Leaf, flower and stem	randomly	20	14
<i>Ricinus communis</i> L.)	Wondo Genet, alagea, koka,	Plant bug	Hemiptera	Miridae	<i>Dicyphus</i> sp.***	Leaves	entire field	25	20
		hairy caterpillar	Lepidoptera	Lymantriidae	<i>Euproctis</i> sp.***	Leaves	entire field	15	12
		Red spider mite	Acarina	Tetranychidae	<i>Tetranychus</i> sp.****	Leaves	randomly	45	40
		white grubs(C_shape)	Coleoptera	Scarabaeidae	<i>Phyllophaga</i> sp.***	stem	randomly	15	15
		shoot borer	Lepidoptera	Pyraustidae	<i>Conogethes</i> sp.***	Leaves	entire field	25	15
<i>Vernonia galamensis</i> L.	Wondo Genet	Halmet bug	Hemiptera	Pentatomidae	<i>Captosoma</i> sp.***	Leaves	randomly	15	12
	Wondo Genet & Hawassa	Caterpillars	Lepidoptera	Erebidae	<i>Achaea</i> sp.**	whole parts	randomly	10	7

Key→ * = very low, ** = low, *** medium, ****= high, *****= very high (damage levels).

hairy caterpillar (*Euproctis* sp.), stinkbug (*Nezara* sp.), and grass hoppers (*Ornithacris* sp.) were observed as insect pest on castor with different rate of infestation and damage level in surveyed area in Ethiopia.

VI. INSECT PESTS ASSOCIATED WITH VERNONIA

Vernonia has a number of pests which causing considerable damage. Halmet bug (*Captosoma* sp.) and caterpillars (*Achaea* sp.) were minor insect pests infest *Vernonia galamensis* L. causing medium damage level and infestation rate in Wondo Genet and Hawasa (Table 2). Similarly study conducted by [16] reported that vernonia worm (*Indent* sp.) followed by helmet bug (*Captosoma* sp.)

were important pests of *V. galamensis* in Ethiopia that are support our findings. [20] also explained that aphids (*Aphis gossypii* Glover), blister beetle (*Mylabris* sp.), cluster bugs (*Agronoscelis pubescens* (Thunb.)), epilachna beetles (*Epilachna* sp.), green grasshopper (*Ornithacris* sp.), green stick bug (*Nezara viridula*(L.)), harlequin bug (*Bagrada* sp.), helmet bug (*Captosoma* sp.), leaf miner (*Liriomyza* sp.), lygaeus bug (*Lygus* sp.), spiny boll worm (*Earias biplaga* (Wkl.)), striped blister (*Epileauta* sp.), and vernonia worm (*Indent* sp.) were insects associated with *Vernonia* in Ethiopia.

VII. DISEASES ASSOCIATED WITH PHYSIC NUT

The powdery mildew caused by the fungus *Pseudoidium jatrophae* attack physic nut at all growing stage and causes 97% and 62.6% disease incidence and disease severity, respectively (Table 3). Powdery mildew damages leaves, shoots, flowers and fruits acquire a dusty white to gray coatings which turn into black patches with severe infection and time. The most common symptoms of the disease are the production of abundant white or gray mycelia in leaves, petioles, stems, flowers and fruits (Fig. 1e). The disease cause leaf fall, under development, death of buds and young fruit deformation. This disease occurs commonly in physic nut plantations and it has been frequently observed in various regions of Ethiopia. Physic nut infected with yellow mosaic disease *Begomovirus* sp and attack at flowering stage due to transmitted by insect pests mean that during flowering attract insects (Fig. 1f). Anthracnose caused by *Colletotrichum* spp. attack physic nut causes 60% and 30% disease incidence and disease severity, respectively (Table 3). Symptoms are brown to black necrotic lesions that are irregularly shaped and appear on the edges and center of the leaf and which may contain a yellow halo. The lesions appear in the form of small, isolated points that coalesce and subsequently cause the complete destruction of the leaves (Fig. 1g). The fruit can also become infected, which leads to the appearance of dark brown lesions.

VIII. DISEASE ASSOCIATED WITH CASTOR

Rust caused by *Melampsora ricini* attack castor at young to old stage cause drying of leaves and causes 60% and 30%

disease incidence and disease severity, respectively (Table 3). Wilt caused by *Fusarium oxysporum* attack castor at seedlings stage. Wilting of plants, root degeneration, collar rot, drooping of leaves and necrosis of affected tissue and finally leading to death of plants. Young to old stage cause drying of leaves and causes 5% and 35% disease incidence and disease severity, respectively. Leaf blight caused by *Alternaria ricini* attack castor at all stage (Fig. 2l). Show dark brown lesions with concentric rings and attack all the aerial parts of plants and causes 20% and 25% disease incidence and disease severity, respectively. According to [19] *alternaria* sp., *fusarium* sp., *cercospora* sp., *xanthomonas* sp., *melampsora* sp. and rusts were the major disease of castor that support our findings.

IX. DISEASE ASSOCIATED WITH VERNONIA

Powdery mildew caused by *Erysiphe* sp attack *Vernonia* at flowering and maturity. Cottony like mycelia on leaves, young leaves are more susceptible, flower abortion and leaf and fruit drop (Fig. 3k) and causes 87% and 55% disease incidence and disease severity, respectively (Table 3). Wilt caused by *Fusarium* sp., attack *Vernonia* at seedling, flowering, and maturity causes wilting and killing plants (Fig. 3j) and causes 20% and 40% disease incidence and disease severity, respectively (Table 3). Report indicate that damping off (*Rhizoctonia solani*) (Kuhn), *Fusarium* sp. Seedling Leaf blight, Leaf spot (*Alternaria* sp.), *Phoma* sp., Powdery mildew (*Erysiphe* sp.), Rust (*Puccinia* sp.) and Wilt (*Fusarium* sp.) were pathogens associated with *Vernonia* in Ethiopia [20].

Table 3. Pathogens associated with physic nut, castor and vernonia between 2013-2016 in some growing of Ethiopia

Crops	Common name of pathogens	Scientific name of pathogens	Disease Severity (%)	Disease Incidence (%)
Physic nut	Powdery mildew	<i>Pseudoidium jatrophae</i>	95	75.5
	Virus	<i>Begomovirus</i> sp	20	10
	Anthracnose	<i>Colletotrichum</i> spp.	60	30
Castor	Rust	<i>Melampsora ricini</i>	75	35
	Fussarium/wilt	<i>Fusarium oxysporum</i>	35	15
	Leaf blight	<i>Alternaria ricini</i>	25	15
<i>Vernonia</i>	Powdery mildew	<i>Erysiphe</i> sp	90	75
	Wilt	<i>Fusarium</i> sp	50	20



a. Mealybug (*Paracoccus marginatus*) incidence on physic nut



b. Red spider mite (*Tetranychus* sp.) on physic nut



a. Capillary



b. Flour Beetles (*Tribolium* sp.) incidence on Physic nut



c. Powdery mildew on physic nut



d. Physic nut infected with yellow mosaic disease



Anthracnose on physic nut

Fig. 1. Insect pests (a, b, c, and d) and pathogens (e and f) associated with physic nut plants in some growing area in Ethiopia



g. Red Spider mite *Tetranychus* sp on castor



f. Leaf blight- *Alternaria ricini*

Fig. 2. Insect-pests (h) and disease (i) associated with castor plants in some growing area in Ethiopia



g. *Fusarium* sp. on vernonia



h. Powdery mildew (*Erysiphe* sp.) of vernonia

Fig. 3. Pathogens (e and f) associated with vernonia plants in some growing area in Ethiopia

X. CONCLUSION

The present study provided some clues to the understanding of the distribution, composition and economic importance of insect pests and diseases of non-edible oil crops in Ethiopia. Understanding the situation of non-edible oil crops pests will help to eventually achieve an economically sound and efficient insect pests and disease management strategy. Future research emphasis should be given due concern for the development of integrated/appropriate pest management strategies for economically important pest of non-edible oil crops for higher production and productivity. The major non-edible oil crops 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 and fossil fuel it is necessary to develop cost effective pest management practices with environmental concern.

XI. ACKNOWLEDGMENT

The authors are grateful to the Wondo Genet Agriculture Research Center for providing all the necessary facilities and support during the entire experiment. Our special thanks also go to Mokonnen Dejene and Genet Dejene for their help in field and laboratory analysis.



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