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A Review on the Potential of Ethiopian Flora for Botanical Pesticides to Control Crop Pests: Contribution for plant conservation

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Abstract

This paper is to provide an overview of the data published mostly on plant extracts and plant based products from plants grown in Ethiopia that have been reported to possess bio pesticidal activity on agricultural pests. For data collection, this review used secondary data available from google under appropriate search engines. The review has revealed a total of 62 different plants distributed in 31 different families. The plant part used, lethal does, the type of crop protected, the type of pest controlled by plant based products and their biological activities, geographical distribution in the Floristic region and altitudinal renge were documented. This work provides basic information to users and triggers people to conserve and use these plants in the future.

Keywords: Botanicals, Pests, Secondary Metabolites

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Introduction

Ethiopia is a land of great topographical diversity of high rugged mountains, flat topped plateaus, deep gorges, incised river valleys and rolling plains, which are responsible for tropical, subtropical and temperate climatic conditions (IBC, 2008). Due to this topographic and climatic variability, this country contains about 6027 vascular plant species (Kelbessa and Demissew, 2014) in different Floristic regions. Plant use researches were identified more than 1000 medicinal plants (Asfaw and Wondimu, 2007) and 413 wild edible plants Luelekal et al., (2011). was also indicated that a total of were also identified and stile many studies have been undertaking in different research institutes to practice knowledge based conservation. Globaly It has been estimated that 14 - 28% of higher plant species are used medicinally and that 74% of pharmacologically active plant derived components were discovered after following up on the ethnomedicinal uses of the plants (Ncube et al., 2008).

Although plants are sessile organisms and cannot escape danger in the way that animals do, they are not completely defenseless. Plants have different forms of defense, ranging from structural traits (Agrawal, 2011) and barriers (Hanley, 2007) to physiological (Carmona, 2011) and chemical defensive mechanisms (Mitho¨fer and Boland 2012). Due to the presence of secondary metabolites, plants have been reported to exhibit a wide range of biological activities against insect pests, some of which have been scientifically validated (Odeyemi et al., 2008).

Plants produce a wide spectrum of secondary chemicals in various tissues above and below ground that are used not only to defend themselves against biotic or abiotic stressors (Holopainen and Gershenzon 2010) but also used as medicines (Halberstein, 2005), food- and beverage-flavoring agents, fragrances, textile dyes, hygiene products (Balick and Cox 1996), and pest and disease management tools (Isman, 2000).

The defensive roles of plants are also used in the agriculture sector for crop management. However African agriculture is largely traditional, and pest management is a built-in process in the overall crop production system rather than a separate, well-defined activity (Abate et al., 2000). By its nature, traditional agriculture is characterized by diversity of practices and genetic resources where farmers manipulate and derive advantages from local resources and natural processes (Altieri, 1995). Even though this traditional agriculture system has been using both chemical and biological pesticides, using biological pesticides as an integrative pest control have many fold advantage (Chandler et al. 2006).

Different scholars indicated that using chemical pesticides for crop pest control has different health and environmental problems (khtar, 2012). Negative effects on human health led to a resurgence in interest in botanical pesticides because of their minimal coasts and ecological side effects. As Koul et al. (2008) indicated that the environmental problems caused by overuse of pesticides have been the matter of concern for both scientists and public in recent years. Natural products are an excellent alternative to synthetic pesticides as a means to reduce negative impacts to human health and the environment (Isman and Machial, 2006). Therefore, in this review, the researcher aimed to explore experimentally proved botanicals from plants found in the Ethiopian Flora: to document botanicals with their floristic region; to provide basic information about botanicals and associated pests controlled

by specific plants and to recommend use based conservation of selected plants

Materials and Methods

To explore, identify and screen botanicals used for crop pest management, the author of this review was used Google scholar with different search terms like botanical pesticides, secondary metabolites, phytochemicals, allelochemicals and storage pest control. The literatures reviewed were highly dependant on articles that address plants found in the Ethiopian Flora if not, the papers were not considered for the review. From each review paper, the plant part used, lethal does, the type of crop protected, the type of pest controlled by plant based products and their biological activities, geographical distribution in the Floristic region and altitudinal renge, ethno botanical information's before investigation; used for integrated synthetic pesticides and references were properly identified and recorded.

Results and Discussion

3.1 Plant Diversity in the Ethiopia Flora used for Botanicals

This review had divulged experimentaly tested botanicals from the Ethiopian Flora which control crop from potential crop pests mainly insects. The google search under different search engine and other available sources were resulted a total of 62 different species of plants. These plants were distributed in 31 different families. The majority of plants were found in Asteraceae (19%=12), Fabaceae (11%=7) and Solanaceae (9.5%=6). Leaves of half of the reviewd plant were used as asourse of botanicals followed by aerial part (23%) and seed (8%) (Fig 1). The plant sample were prepaired in the form powder and directly applied or dissolved by water and spray, or polar and non-polar solvents for direct application the details were presented on (Apendix 1) can extract it. The geographical distribution of the reviewed plants with its altitude were also documented and presented in (Appendix 2). The habits of most of the botanicals were belonging to herbs and are herbaceous followed by shrubs (Fig 2). Being herbaceous is an opportunity for users to cultivate in a very small area and used easily to control crop pests mainly insects.

3.2 Major Ethiopian crops and respective botanicals in the Ethiopian Flora

Food grain production in Ethiopia takes place during two periods of rainfall, the

main (meher) rains from June to September and the belg rains from February to May. Over 80% of production is on peasant farms during the meher season and over 60 % of this production is in Oromia Amhara and Southern region (CSA, 1997). Reports by CSA (2014) indicated that, the majority of cereal crops produced at large in meher season are Maize 72,248,481, Teff 47,506,573, Sorghum 43,319,062, Wheat 42,315,887, and Barley 19,533,848 of the total 235,903,211 quintal cereal crops; Horse beans white 8,389,353, Chick – peas 4,586,823, Soya beans 20,044 Horse beans red 3,426,337, Haricot beans 3,116,038 of the total 26,718,345 quintal pulses: Ethiopian cabbage 3,264,466, Red peppers 1,706,541, Green peppers 367,145, Head cabbage 289,190 of the total 5,947,370 quintal vegetable crops; Sweet potatoes 27,001,317, Taro / 'Godere' 14,443,342 , Potatoes 9,217,351, Onion 2,307,452 of the total 54,554,894 quintal of Root Crops; With the exception of teff all of these crops are susceptible to pre and post –harvest losses caused by insects.

a. Maize (Zea mays L.)

Maize is aleeding crope among cereals in Ethiopia. It accounts more than 30 % of the total cereal crop production (CSA, 2014).Stem borer (Busseola fusca) is the most insects that affect it at young stage of growing (during harvest). This pest is highly affecting this group of crop during harvest whereas weavils (Sitophilus zeamais) is highly affecting stored maize during post harvest (Shiberu, 2013a; shiberu 2013b & Muzemu et al., 2013). The review indicated that, leaf and stack powder of Cymbopogon citratus (DC.) Stapf. and flower powder from Tanacetum cinerariifolium (Trev.) Sch. Bip. (Shiberu 2013a; Shiberu 2013b) were the best statisticaly significant contribution to control Stem borer (Busseola fusca). The effect of weavils on stored maize can be controlled by leaf powder extracts from Carica papaya L. Tagetes minuta L and Eucalyptus tereticornis (Muzemu et al., 2013).

c. Wheat (Triticum species)

Wheat is also the 3rd most produced cereal crop accounts more than 17% of the total (CSA, 2014). So far the Ethiopian agricultural system tried to use chemical pesticides to control wheat pests, this review paper was showed the presence of botanicals from the Ethiopian flora that controls wheat stored pest i. e., Trogoderma granarium. Among these, methanole extracts of leaves of Cassia senna L., Caesalpinia gilliesii (Hook.) Dietr. , Thespesia populnea var.acutiloba (L.) Solander ex Co, Argyranthemum

frutescens (L.) Sch. Bip., Bauhinia purpurea L., and Cassia fistula L. (Derbalah, 2012) were used as a sourse of botanicals. All of these plants and its botanical extracts have statistically significant potential to contro this pest under laboratory condition i.e 100%. See detailsa from (Appendix1)

d. Vegetables

In this review papper we compiled botanicals used as pest controle in selected vegetables like Onine (Allium sativum), Tomato (Solanum esculantum) and Ethiopian cabbage (Brassica oleraceae). Other vegetables and its respective botanicals were listed on (Appendix 1). Some of experimentaly approved botanicals to control onion thrips were Seed powder of Phytolacca dodecandra L Herit., Leaf and stalk powder of Nicotiana spp., (local var.), flower powder of Tanacetum cinerariifolium (Trev.) Sch. Bip. and seed powder of Azadirachta indica A. Juss. (Shiberu et al., 2013); Tomato (Solanum esculantum L.) was protected from list of insect pests like Spodoptera littoralis, Myzus persica and Tetranychus urticae by botanicals Thymus vulgaris L, (oil); Tanacetum cinerariifolium (Trev.) the researcher Sch. Bip (pyretrin 3%). and Azadirachta indica A. Juss. (Neem 3%) (Pavela, 2009). Ethiopian cabbage (Brassica oleraceae) is protected from a group of pests like larvae of Peris brassicae by leaf powder from Azadirachta indica A. Juss. And Plutella xylostella moth by leaf powder from Melia azedarach L. A commercial product Neemix 4.5 ®) from Azadirachta indica A. Juss. is also used to protect this insect pest (Charlestona et al., 2006). See detailsa from (Appendix 1)

e. Root crops

Among root crops grown in Ethiopia, Sweet potato (Ipomia batata) is a leading crop which accounts 49 % (CSA, 2014) of the total 54,554,894 quintal of Root crops production. This important crop is affected by pests like Beet army worm (Spodopetra exigua). The review paper provides tested botanicals i.e., methanole extraction of Melia azedarach L. root (Travis & Mix, 2012).The detailed botanicals used to control phytophagous insects and other crop pests with its efficacy and Floristic region were presented on (Appendixe1).

3.3 Botanicals used to control different crop pests

a. ***Azadirachta indica A. Juss.***

Azadirachta indica is a tree up to 15 m tall, Introduced; native of India and Burma. In Ethiopia planted as an avenue tree in IL and KF and probably elsewherebelow 1500 m (Hedberg and Edwards, 1989) .In this

review papper the leaf and seed part of Azadirachta indica A. Juss. Plants have been used to protect crops from pests. Seed powder of this plant experimentaly protects onin from onin thrips (Thrips tabaci) Shiberu et al., 2013; Tea plants (Camellia sinensis L.) from Aphids (Toxoptera aurantii) (Sohail et al., 2012); tomato (Lycpersicon esculentum Mill.) from Spodoptera littoralis and Myzus persicea (Pavela, 2009). The leaf of this plant also used to protect Solanum melongena L. from different types of fungal infection like Fusarium oxysporum, Curvularia lunata, and Aspergilus flaxus (Kuri et al., 2011); cabbage (Brassica oleraceae) from Tetranychus urticeae (Hasan and Ansari, 2011); and Cow pea plants (Vigna unguiculata L.) from Maruca vitrata (Oparaeke et al., 2005). Commercialy prepaired pesticides from Azadirachta indica A. Juss plants called Neemix 4.5® has used for protecting cabbage from Diamond back moth(Plutella Xylostella) (Charlestona et al., 2006). See detailsa from (Appendix1)

b. Tanacetum cinerariifolium (Trev.) Sch. Bip.

Tanacetum cinerariifolium is perennial herb, 15-45 cm high and is a native of Croatia and NE Italy and has been widely cultivated, particularly in Europe and USA (California). It has also been widely cultivated, especially in the tropics, as a source of the insecticide Pyrethrine. It was introduced in Ethiopia together with Tanacetum parthenium and maintained as agarden ornamental (Tadesse, 2004).

Tanacetum cinerariifolium (Trev.) Sch. Bip. is used to reduce the effect of pests on different crops. Flower extracts of this plants protect Maize (Zea mays L.) from Buseola fusca (Shiberu, 2013a; Shiberu, 2013 b); Onins (Allium sativum L.) from Onion thrips (Thrips tabaci) (Shiberu et al., 2013); Strawberry from Western flower thrips (Frankliniella accidentalis) (Vacante and Bonsignore, 2012). There is also commercialized pesticide product from this plant called Pyrethrine used for protecting tomato (Lycpersicon esculentum Mill.) from Spodopetra littoralis (Pavela, 2009). See detailsa from (Appendix1)

c. Nicotiana tabacum L.

Nicotiana tabacum L is herb up to 2 m or more tall. It is Cultivated in villages, in homegardens or in specialised tobacco-farms, sometimes escaped; it can be grown in between 300-2400m. In Ethiopia it can be grown in TU, GD, SU, WG, KF, GG SD HA; It is indigenous in America (probably originally temperate South America); now widely cultivated, escaped and-naturalized

throughout the warm parts of the world (Hedberge et al., 2006).

In this review the leaf and leaf and stack powder of Nicotiana tabacum L. were used to control maize (Zea mays L.) from Busseoa fusca (Shiberu, 2013b) and onion (Allium sativum L.) from onion thrips (Shiberu et al., 2013). Leafs of this plant also used to control Maize (Zea mays L.) from Buseeeola fusca (Shiberu, 2013a); Tea plants from aphids (Sohail et al., 2012); cow pea from callosobruchus maculatus (Opolot et al., 2006); tomato from different insects like Aphis frangulae, Myzus persicae, Heliothrips haemorrhoidalis and Parthehothrips dracaena (Zarins et al. , 2009).See detailsa from (Appendix1)

d. Securidaca longepedunculata Fresen.

Shrub or small tree up to 6 m tall found in Wood land or wooded grass land with Terminalia, Combretum, Protea gardenia etc., subject to burning; typically grown in between 500-1750m. In Ethiopia it is found in TU, GD, GJ, WG, SU, IL, GG (Edwards et al., 2000). Root bark powder of this plant has been used to control maize and onin from Busseola fusca and onion thrips respectively (Shiberu, 2013 a; shiberu 2013b; Shiberu et al., 2013). See detailsa from (Appendixe1)

e. Artemisia absinthium L.

Artemisia absinthium L. is an erect, perennial herb with 30-60cm high. It is widely cultivated especially in the northern and central parts of the Flora area for its aroma and widely applied in rituals called "adbar" and inflavoring locally distilled Alcoholic drink called AREKI (in amharic); it can be grown in between 1700-2350 (-2440) m. In Ethiopia this plant is typically found TU, GO, SU, WG, HA; it is native to the Mediterranean-region but widely cultivated in the temperate world for the active ingredient used in the alcoholic drink absinthe (Tadesse, 2004). Aerial parts of Artemisia absinthium is used to control Phytophages insects like Tetranychus urticae (Spider mite, polyphagous) (Chermenskaya et al., 2010). It can feed on hundreds of plants, including most vegetables and food crops – such as peppers, tomatoes, potatoes, beans, maize, and strawberries and fall web worms (Hyphantria cunea) (Brudea et al., 2012) feeds on just about any type of deciduous tree, where leaves are chewed.

Powders from aerial part of this plant is also used to protect Straw bery from the effect of Western flower trips (Frankliniella occidehtalis) (Vacante and Bonsignore, 2012). Phytophagous insects are differentiated into three categories such as

monophagous, oligophagous and polyphagous. The insect species which feed on plants under single genus termed as monophagous. The oligaphagous type consumed wide range of plants of different genera but in a single plant family. Whereas a polyphagous insect refers that they are feeding wide range of plant under different plant families (Bernays and Chapman, 1994)

f. Cymbopogon citratus (DC.) Stapf

Cymbopogon citratus (DC.) Stapf (Lemon grass) is cultivated on a large scale in parts of South America and Asia for medicinal and culinary purposes. It is grown around houses in Ethiopia for its fragrant foliage and can be recognized by the lemon scent of the leaves when crushed and by its awnless spikeletes (Phillips, 1995). Late alone the above mentioned purposes aereal part of this plant is used as botanicals to control maize from Larvae of Busseola fusca (Maize Stem Borer) attack (Shiberu, 2013a; Shiberu, 2013b) and onion from Onion thrips (Shiberu et al., 2013). See detailsa from (Appendix1).

4. Short comings of the review

This review has included mainly articles available from Google. Unpublished research results of any type and journals not easily available which are restricted not openly accesed were also not included. These were unquestionably affected to see the overall potential of Ethiopian flora for botanicles. Besides, the majority of tested botanicals were examined under lab condition that might not be fully adovacted unless exostive field trials were conducted. Another challenges regarding to such kind of work is eventhough researchers were confirmed the potential of some botanicals for pest control, registyration of this groups of pesticides required a serious of analytical procedure that demands a lot of money and expertise. For complet profile continuous work like this might be done in the near future to see the full image of our Flora for botanicals. From ethnobotanical point of view, almost all reserchers were not acknowledging the knowledge source. This might affect the conservation of the plants by the peple who use it.

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