Journal of Agricultural Science and Food Research

Duressa, J Agri Sci Food Res 2018, 9:1

Review Article Open Access

Newly Emerging Insect Pests and Diseases as a Challenge for Growth and Development of Ethiopia: The Case of Western Oromiya

Duressa TF*

Department of Entomology, Naqamte Plant Health Clinic Center, Oromiya Bureau of Agriculture and Natural Resources, Naqamte, Oromiya, Ethiopia

***Corresponding author:** Duressa TF, Department of Entomology, Naqamte Plant Health Clinic Center, Oromiya Bureau of Agriculture and Natural Resources, Naqamte, Oromiya, Ethiopia, Tel: +251910865935; E-mail: tfduressa@gmail.com

Rec date: November 02, 2017; **Acc date:** December 21, 2017; **Pub date:** January 05, 2018

Copyright: © 2018 Duressa TF. This is an open-access article distributed under the terms of the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original author and source are credited.

Abstract

Agriculture is a key driver of Ethiopia's long-term growth and food security. It directly supports 85 percent of the population, constitutes 43 percent of Gross Domestic Product (GDP) and 80 percent of export value. Nearly, 16 percent of GOE's public expenditures are committed to the sector. However, sustainable productivity of the agricultural sector is threatened by newly emerging insect pests and diseases in the country in general and western Oromiya. This paper discusses on a newly emerging agricultural pest (Diseases and Insects) as a challenge of crop production in western Oromiya. The area is known by maize, mango and ginger production in the country. However, production of these crops was becoming under risk due to Maize Lethal Necrotic Virus Diseases (MLN) of maize, Leaf and Fruit Spot of citrus (*Pseudocercospora angolensis*), Bacterial wilt (*Pseudomonas solanacearum*) of ginger, Tomato leaf miner of tomato (*Tuta absoluta*) and White Mango scale insect (*Aulacaspis tubercularis*) of mangoes. Currently, these pests were key agricultural pests which are introduced recently in the area. Because of these sever damage up to 95% loss of mangos in east Wollega zone due to white mango scale. In addition, MLN caused a serious yield loss on maize in 2013/14 cropping season in the country. Hence, these pests are now seen as severely attacking crops and they are challenges to the country. These pests were considered as threat to the growth and development of the western parts of Oromiya. Thousands of small holder farmers in western Oromiya suffer from food insecurity due to lack of the requisite education, information, training and management strategies regard to alien and resident crop pests. Therefore, more investment in improving plant protection is needed to ensure long term food security of the region and establishment of strong quarantine to protect the entrance of new insect pests and diseases were highly needed in the country.

Keywords: Maize Lethal Necrotic virus (MLN); Citrus leaf and fruit spots; Ginger bacterial wilt; White mango scale insect; *Tuta absoluta*

Introduction

The challenges of combating alien pests were among the major constraints seriously affecting the sustaining and accelerating production and productivity of agriculture in Oromiya. Agriculture is the center of sustainable development mainly in developing countries like Ethiopia to meet the national food requirements and economy and it's considered as the backbone of Ethiopia's economy that contributes about 50 percent of the GDP and employs 80% of the population [1]. Agriculture is a key component of growth and development in slashing poverty and transforming the economies of the country that accounts large shares in national income, employment and exports contributing significantly; to the growth and poverty reduction in Ethiopia. In western Oromiya region most of the population lives in the rural areas and almost all the rural households depend directly or indirectly on agriculture. That mean, agriculture affects the economic growth of the region through its potential to stabilizing domestic food production and enhance food security. It's the largest employer in Ethiopia either directly or indirectly engaging most of the labor force. Because agriculture plays such a significant role in the economy, any fluctuation in it can easily shake up the GDP of the country. Although agriculture plays such significant role in the economy of Ethiopia, it is facing many challenges in western Oromiya. In the region agricultural systems were seriously threatened by both biotic and abiotic factors. Abiotic factors such as soil acidity, erosion, inappropriate land use system, soil and water conservation and soil fertility are the major one. In addition, many biotic factors also constraints crop production; Insects, diseases (Bacteria, Fungi and virus) and weeds are among the common problematic in agriculture. Previously insect pests mainly maize stalk borer and diseases such as maize streak virus, maize rough dwarf virus, common smut and grey leaf spot were considered as major pests challenging maize production in the region.

However, currently, a newly emerging alien pest such as mango white scale (*Aulacaspis tubercularis*) insect on mango [2], Tomato leaf miner (*Tuta absoluta*) on tomato [3], and maize Lethal Necrosis Virus (MLN) diseases on maize [4], citrus leaf and fruit spot (*Pseudocercospora angolensis*) on citrus [5,6] and bacterial wilt of ginger [7] were among the major biotic constraints affecting agriculture in the region.

These are among economically important pests altering the production and productivity of agriculture in the region causing a significant yield reduction and seen as a newly emerging pest of agricultural crops. Due to these pests thousands of smallholder farmers in western Oromiya suffer from food insecurity which could affects the small scale traditional farming system of the area. Decline of farmers income and food insecurity, an increase in crop production costs and yearly losses, as a result the growth and development of agricultural crops in Oromiya were seriously threatened. These detrimental pests were introduced into the country unknowingly probably due to poor quarantine and they are considered as agroterrorism of agriculture to the rural development of the western parts of Oromiya. Moreover,

despite the economic importance of alien insects, weeds and diseases, there were no collaborative research and development efforts in the country. More investment in improving plant protection is needed to ensure long term food security of the region and development of the country through controlling newly emerged insect pests and diseases due to lack of biosecurity/quarantine/. Therefore, the aim of this paper is to discuss on economically important alien disease of maize, citrus, ginger tomato and mango in the western Oromiya region and to disseminate information on the newly introduced pests in the region; to suggest future research and development directions towards its management.

Information sources

Information for both insect pests and disease were collected from Western Oromiya (West, East and Horo Guduru Wollega zones), Oromiya. Secondary data review was made on the relevant secondary information sources including the collection and review of the already existing data from various relevant previous research findings on the topics moreover, included physical observation on mango farms, maize farms, citrus, tomato and ginger field. Consultation made with knowledgeable individuals and review of previous similar studies on the topics.

Discussion

White mango scale insect (*Aulacaspis tubercularis* Newstead (Hemiptera: Diaspididae))

Mango is one of the most important income-generating fruit in the rural communities of western Oromiya and contributes to the country's economy through feeding the local community, ecological balance and foreign exchange earnings. In Gambella and South West Ethiopia mango is the first fruit and only proceeded by banana [8]. Many resource poor farmers sell their mango fruits to the local markets without further processing and use it to purchase livestock, agricultural inputs, food crops, teaching equipments for their children and other household items. However, recently, in west Oromiya mango production is buffeled mainly by white mango scale (*Aulacaspis tubercularis*) insect. This insect pest is an important biotic factor that causes damage to the fruits resulting in serious economic losses and making the fruits less quality. *A. tubercularis* was first recorded in Ethiopia, Oromiya, East Wallaga zone in Green focus Ethiopia private Ltd. farm at Loko in Guto Gida district in 2010 [2]. At the moment farmers were uprooting mango trees from their farm because there are no available management strategies still for the region and that could directly affect further expansion of mango in the country. *A. tubercularis* is increasing its incidence at an alarming rate in Western Oromiya (Figure 1) [9].

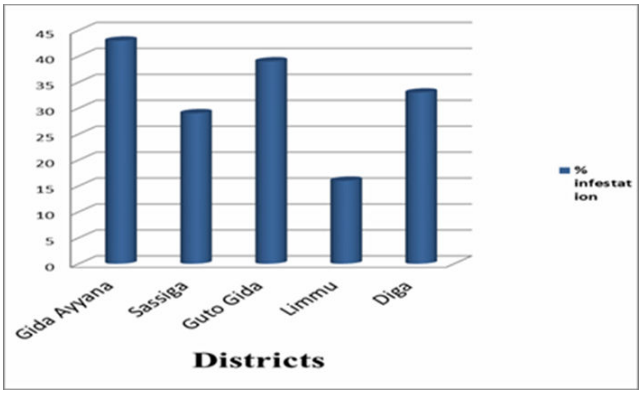

Figure 1: White mango scale insect infestation status in Western Oromiya (five districts) [9].

A. tubercularis injures mangoes by feeding on the plant sap through leaves, branches and fruits, causing defoliation, drying up of young twigs, poor blossoming and so affecting the commercial value of fruits especially to late cultivars where it causes conspicuous pink blemishes around the feeding sites of the scales. Heavily infested premature fruits dropping, and the mature fruits became small with lack of juice. Although the white mango scale causes only cosmetic damage to the fruit, they can result in serious economic losses since the fruits are rendered unfit for export [10]. According to the report of [2] the infestation of white mango scale insect has been speeded at an alarming rate indicating that 43%, 29%, 39%, 16%, 33% in Gida Ayyana, Sassiga, Guto Gida, Limu and Diga respectively, but now up to 95% infestation was recorded at Guto Gida District (Personal view). The insect can be distributed from infested to free area via infected seedlings of mango since the insect is too small it can be easily distributed up on wind direction. Except Qellam Wallaga, all Mango growing area; east, West Shawa, some parts of west and Horro Guduru Wallaga, were infested by white mango scale, *A. tubercularis* insect in Oromiya (Table 1). It's expected that in the meanwhile, unless some management strategies have been developed, mango farming will be collapsed in the region.

S. No.	Zone	District	No. of Villages	Area (Hac.)	No. of trees infected	No. of House holds	Severity %	Year occurred	Remarks
1	East Wellega	G/Ayana	6	843	190192	7928	65	2003	
		limu	7	512	165625	5336	85	2003	
		Sassiga	8	34	9216	117	Jul-26	-	
		G/Gida	10	58	13656	8561	65	2002	
		Diga	12	2693	538600	4896	82-85	-	

		Forest and wild life instution	-	221	14807	East Wellega	60	-	Earlier state farm
		Mango				Branch			
2	H/Guduru Wellega	Abe Dongoro	6	80	50000	1780	100	-	
3	West Wellega	Gimbi	3	32.3	19320	184	40	2003	
		Total	53	44,473.30	1001416	28802	-	-	
4	Benishangul Region	Beloji Genfo	Reported						

Table 1: Infestation status of White mango scale (*Aulacaspis tubercularis*) in Western Oromiya, Oromiya region [7].

White mango scale can be managed by cultural, biological, chemical and integrated pest management methods. Post-harvest pruning is considered as effective management of the insect and for the penetration of tree canopy for chemical spray. Numbers of biological agents have been used for white mango scale insect control. The role of predatory beetle, *Cybocephalus binotatus* was well indicated by. The use of parasitoid, *Aphytis chionaspis* as a biocontrol in South Africa was also resulted in effective contribution in the management of *A. tubercularis* [10]. Different pesticides have been also used mainly mineral oils (super masrona®, CAPL2® and Diver®) [11]. More recently in developed continents like Australia, a softer but powerful and '2-way systemic' (Movento® 240 SC) have been used for scale pest management in mangoes.

Leaf and fruit spot of citrus (*Pseudocercospora angolensis*)

As reported, citrus is among the most important fruit crops grown in Ethiopia [12]. Citrus is economically an important fruit as food source, income generation and source of employment in western Oromiya. However, citrus production is seriously hampered by a fungal disease caused by *Pseudocercospora angolensis* [13]. The diseases are widely distributed and threatened to South, South-west and northwest [14] and south-eastern region [5,6] of Ethiopia. Currently, the diseases were observed over a vast area of Western Oromiya affecting citrus production by causing premature leaf defoliation and loss of fruit quality (decreased the market value of the citrus). Symptoms seen on a mature fruit includes; circular brown raised corky lesions which were thickened and resinous, most with cracked centers (Figure 2). It was confirmed that isolations made from lesions on such fruits consistently revealed a fungus identified by morphological characteristics as *P. angolensis* [15]. The diseases can also attack leaves of citrus and morphologically leaf spots surrounded with yellow halo.

Figure 2: Typical *Phaeoramularia angolensis* lesions on fruit and leaves (Leave of sweet orange attacked by *P. angolensis*, Najjo TVET College) of citrus West Wallaga. Photo credited to Tarekegn Fite.

P. angolensis is farmer's economic concern in western Oromiya including most of the humid tropics of Africa; causing considerable loss to citrus mainly sweet orange. The most important effects of the disease are the premature abscission of young fruit and leaves and the development of fruit lesions which render the fruit unmarketable [16]. Farmers in western Oromiya reported many of the fruit lying unripened on the ground before maturation with an estimated yield loss of more than 70% in West Wallaga, Begi District (Unpublished district communication). The yield reduction due to this disease can reach 50%-100% when climatic conditions are favorable to the disease development, and a timely effective control measures are not taken [17]. The development and spread of *P. angolensis* is favored in areas with high rain fall and humidity above 75%. The pathogen is a dematiaceous hyphomycete occurring in sub-Saharan Africa and Yemen. This fungus requires moisture for infection and the production of wind-borne conidia and under natural conditions, spores of *P. angolensis* probably spread by air-borne conidia [18]. Leaves of planting material or fruits seem the most likely path-ways for the transfer of the pathogen.

Management of *P. angolensis* is focus on host-plant resistance, botanical control (*Eucalyptus saligna* and *Eucalyptus camaldulensis*) [19], cultural (sanitation, use of wind break, removal of infected and defoliated leaves and dropped fruits) and fungicide application [5,14]. Due to environmental and food safety concerns, it is mandatory to investigate other disease management practices against leaf and fruit spot disease of citrus. Many fungicides have been recommended against leaf and fruit spot of citrus in different parts of Africa. Benomyl, Chlorothalonil and Copper hydroxide were recommended as foliar spray in Ethiopia and Kenya [12,18].

Maize Lethal Necrosis Virus (MLN) diseases

Maize, *Zea mays* L. is one of the most important stable cereal food crops for human consumption in rank first in production in Ethiopia. However, maize production is endangered by many insects, weeds and diseases caused by fungi, bacteria, viruses and nematodes were among common problems to the western part of Oromiya. Among insect's, maize stack borer is the most challenge in maize production. Maize grey leaf spot, maize streak virus, maize rough dwarf virus, common stum, Tricicum leaf blight on some maize varieties, rusts were among pathogens constraining maize production in west Oromiya and recently, there is a report on newly emerged maize diseases confirmed as maize lethal necrosis virus (MLN) disease in seed multiplication fields [4] (unpublished) that contributed to high yield losses within a short period of its infection. In Africa it is first reported in Kenya in 2011 and expanded to Uganda, Tanzania and Ruanda. The disease is caused by co-infection of Maize Chlorotic Mottle Virus (MCMV) and Sugar Cane Mosaic Virus (SCMV) or with other cereal potyviridae viruses like the Wheat Streak Mosaic Virus (WSMV) or Maize Dwarf Mosaic Virus (MDMV).

The diseases seriously affect yields and sometimes also cause complete loss of yield and caused 30-100% yield losses [20,21]. In addition, MLN give rise to secondary fungal development in the ears or grains that makes the infected crop not to be allowed either human or animal consumption. Moreover, MLN is threatening most of maize producers in the surveyed areas of western Oromiya including Beni Shangul Gumuz region and considered as potential pathogen ever seen previously in the countries maize production history that would directly affect maize value chain, increased cost of production that will be a challenge for the country agricultural development. The infected plants in the field show chlorotic mottle to severe stunting (Figure 3B), leaf necrosis (Figure 3C), premature plant death (Figure 3C), and shortened male inflorescences with few spikes, and/or shortened, malformed, partially/no filled ears, dead heart. Chlorotic mottling of the leaves usually starting from the base of the young leaves in the whorl and extending upwards toward the leaf tips (Figure 3A). Likely, the leaves also experience necrosis at the leaf margins that progress to the mid-rib resulting in drying of the whole leaf before tasseling (Figure 3C).

Figure 3: A) Initial MLN symptoms on young plant B) Leaf chlorosis C) Drying before grain filling.

It was reported that, MLN is vector transmittable maize diseases most commonly; thrips *(Frankliniella williamsi*), rootworms (*Diabrotica undecimpunctata*, *Diabrotica longicornis* and *Diabrotica virgifera*), stem borer, and cereal leaf beetles (*Oulema melanopus*) [22,23] and seed transmitted at about 1/2500 (0.04%) [24]. Soil/water and mechanical transmission is also known for MCMV. Alternative host of the disease is *Sorghum*, Johnson grass, Coach grass, *Digitaria* grass, segde grass, *Setaria* spp., Sugarcane, Wheat and Weeds (More than 73 grass spp. were recorded as alternative host for the diseases).

Management methods: Since MLN is strange for the country there is no integrated management strategies developed for the management of MLN. However, below were some of the management options available from world experiences:

- Infected maize should be rouge out/removed from the field at vegetative stage.
- Regular follow up/seed inspector, close supervision and monitoring of seed multiplication fields.
- Regulation of maize products movement from affected areas to diseases-free regions.
- Awareness creation on the disease to public/producers about the introduction of the diseases through press releases, poster, brochures, sensitization workshops and radio programmes.
- Alternative weed control.
- Providing training on MLN identification.
- Testing for Maize chlorotic mottle virus (MCMV) in all seed coming into the country including the material for breeding by concerned bodies.
- MLN vector identification.
- Use of Integrated Pest Management (IPM) practices encompassing all pest management tactics.
- Spraying chemical insecticides for vector control.

Tomato leaf miner (*Tuta absoluta* Meyrick (Lepidoptera: Gelechiidae))

Tomato (*Lycopersicon esculentum* Mill) is one of the most important vegetable crops of large importance in Ethiopia, mainly in Oromiya region. Top priority in vegetable research has been given for tomato since it is a high value commodity [25]. In western Oromiya tomato is cultivated during off season under irrigation by small-scale farmers for local market. Previously bollworms were considered as a major insect pest of tomato in Oromiya. However, recently the tomato leaf miner, (*Tuta absoluta Tuta absoluta* Meyrick) is considered as a serious pest of tomato in the Oromiya region, mainly in the Rift Valley region. *T. absoluta* is a geotropically oligophagous pest of solanaceous crops [26] and the primary pest of tomato.

Currently, in western Oromiya the quality and quantity of tomato were hampered by *T. absoluta*. It is a devastating pest of tomato; larvae can cause losses up to 100% due to attack to fruits. *T. absoluta* is a geotropically oligophagous pest of solanaceous crops [26]. Farmers in East Wallaga, Gobbu Sayyoo district, started to use synthetic insecticides without any recommendation, which resulted in increased cost of tomato production that could affect their income and food security of the region. The use/misuse of chemical for the control of this insect may lead to the destruction of natural enemies, still not identified in the country. The insect deposits eggs usually on the underside of leaves, stems and to a lesser extent on fruits. After hatching, young larvae penetrate tomato fruits (Figure 4A), leaves (Figure 4B) on which they feed and develop creating mines and galleries. Tomato plants can be attacked at any developmental stage, from seedlings to mature stage. Moreover, *T. absoluta* also attack other alternative hosts like; Potato, tobacco, eggplant, peppers, wild- tomato and etc [27].

Figure 4: A) Fruit damage B) Leaf damage by *T. absoluta* larvae C) Larvae of *T. absoluta* and D) Adult *T. absoluta* in East Wallaga, Gobbu Sayyoo District, Oromiya.

The pest has well spreader, invader and established throughout the tomato producing areas of the world. Due to the aggressiveness nature and high reproductive capacity it's very difficult to *T. absoluta.* Since the introduction of the insect, no appropriate management strategies are available in Ethiopia.

Figure 5: Discussion with concerned plant protection experts and advising on pesticide use and empty container disposal mechanisms in East Wallaga, Gobbu Sayyoo District, Oromiya.

Combination of cultural practices such as; crop rotation with non-solanaceous plants, destruction of infested plant material and postharvest debris, removal of wild host plant) is recommended in addition use of various botanical insecticides, synthetic insecticides as last resort (Figure 5), microbial agents (Bt, entomopathogenic fungi) and biological control. Various mass trapping methods with pheromones are also helpful for mass trapping of the pest in field and greenhouse condition.

Bacterial wilt of ginger (*Zingiber officinale* Roscoe)

Among the important spices crops of western Oromiya, ginger is an important cash crop and cultivated by small-scale farmers because of its greater potential of growing due to suitable climatic conditions of western and south-western Oromiya. However, Bacterial wilt caused by *Ralstonia solanacearum* (*Rs*) is an important pathogen affecting ginger and other crops [28]. The pathogen is a lethal vascular disease in the family Solanaceae, attacking economically important crops such as ginger, potato, tomato, pepper and eggplant [28]. In western Oromiya diseases symptoms were first observed in western Oromiya and considered as one of the most limiting factor in ginger production in 2010, since then the diseases were widely distributed and devastating in growing areas of ginger. Bacterial wilt of ginger is economically an important pathogen threatening ginger production in western part of Oromiya that could directly affects the development and growth of the region by decreasing farmer's income and health implication. The bacteria can cause 45% loss in ginger production [29]. Ginger crops can be completely lost to the disease in heavily infested soils. This bacterium infects ginger roots and rhizomes through openings where lateral roots emerge or through wounds caused by handling, parasitic insects, or root-knot nematodes [30]. The most common external symptom of bacterial wilt is: green leaves infected with the pathogen roll and curl ("green wilt"); leaves turn yellow then necrotic; plants become stunted and die; rhizomes are discolored and water-soaked and may be rotting inside. R. solanacearum spreads by infested soil adhering to hands, boots, tools, vehicle tires, and field equipment; in water from irrigation or rainfall; and within infected ginger rhizomes [31]. The pathogen survives in soils within infected plant debris and as free-living bacteria. The pathogen is widely distributed in areas where edible ginger has been grown previously. The host range of *R. solanacearum* race 4 is restricted to edible ginger. In Ethiopia the management of bacterial wilt of ginger has not get the right attention. However, from the world experience some management strategies are available: Planting ginger in well drained soils where ginger had not previously grown; Use of pathogen free seed; planting ginger on hills to aid soil drainage and promote air flow around the rhizome; crop rotation with non-hosts of bacterial wilt.

- The way forward:
- Base line data/survey of mango area in region/should be done.
- Immediate containment campaign with strict local quarantine measures.
- Training and awareness creation for the experts and the public at large.
- Proper fertilization and irrigation of the mango farm.
- Planting of intercrops to improve the field's diversity and to encourage natural enemies.
- Implementation of recommended pruning practices.
- Proper plant sanitation by removing and pruning infested plant parts.
- Mulching to enhance natural enemies and increase soil fertility.
- Monitoring of mango plants regularly at least fortnightly (sufficient number of scout men and plant protection experts are required for regular monitoring and data recording).
- Development of sprayer machine that well suit/fit with the height of mangoes in Ethiopia.
- Pilot trial for recommended safe insecticides like Applaud (growth regulator) and white oil 2% and reduce broad spectrum insecticides.
- High power sprayers are needed for proper application of pesticides on mango trees.
- Monitor scale populations and apply when most crawlers have emerged. This usually coincides with tree flushing after harvest and when fruit are 1.5 to 2.0 cm across.
- Study of population peak.
- Selection of proper mango variety that is well adapted to the local conditions (it is advisable to communicate with agricultural research centers like Melkassa to find locally adapted varieties).
- Selection of good and diseased-free seedlings.
- Introduction of bio-control agents like *Aphytis* spp. and mass production and augmentation in the field.

Conclusion

The challenges of combating alien pests were among the major constraints seriously affecting the sustaining and accelerating production and productivity of agriculture in Oromiya. Agriculture is the center of sustainable development mainly in developing countries like Ethiopia to meet the national food requirements and economy and

it's considered as the backbone of Ethiopia's economy. In western Oromiya were most of the population lives in the rural areas and almost all the rural households depend directly or indirectly on agriculture. Any effect on agriculture, affects the economic growth of the region through its potential to stabilize domestic food production and enhance food security and it's the largest employer in Ethiopia either directly or indirectly engaging most of the labor force. Although agriculture plays a significant role in the economy of the country, it is facing many challenges in western Oromiya. Currently, alien pests such as mango white scale (*Aulacaspis tubercularis*) insect on mango, Tomato leaf miner (*Tuta absoluta*) on tomato, maize Lethal Necrosis Virus (MLN) diseases on maize and citrus leaf and fruit spot (*Pseudocercospora angolensis*) on citrus, and bacterial wilt of ginger were among the major biotic constraints affecting farmers income, food availability and increasing crop production costs. Therefore, combating agricultural pests through Integrated Pest Management (IPM) strategies should have to gain due attention in the country in the future.

References

1. Befekadu D, Berhanu N (2013) Report on the Ethiopian Economy. Annual report. Ethiopian Economic Association(EEA). Volume I. 1999/2000. Addis Ababa, Ethiopia.
2. Mohammed D, Belay H, Lemma A, Konjit F, Seyoum H, et al. (2012) White mango scale: A new insect pest of mango in western Ethiopia. (eds.) In: Proceedings of the 3rd Biennal Conference of Ethiopian Horticultural Science Society (EHSS), Volume 3: 257-267.
3. Gashawbeza A, Abiy F (2012) Occurrence of a new leaf mining and fruit boring moth of tomato, Tuta absoluta (Meyric) (Lepidoptera: Gelechiidae) in Ethiopia. Pest Management Journal of Ethiopia 16: 57-61.
4. OBA (Oromiya Bureau of Agriculture) (2014) Status of MLND in Western Ethiopia. The case of western Oromiya. Annual report. Finfinne, Ethiopia.
5. Eshetu D (1999) Occurrence, Prevalence and control method of Phaeoramularia leaf and fruit spot diseases of citrus in Ethiopia. Fruits 54: 225-232.
6. Kirk PM (1986) Phaeoramularia angolensis. CMI Descriptions of Pathogenic fungi and Bacteria. Mycopathologia 94: 177-178.
7. NPHCC (Nekemte Plant Health Clinic Center) (2014) Ginger bacterial wilf status in Western Oromiya. The case of the Four Wallaga zones. Annual report. Finfinne, Ethiopia.
8. Edossa E, Lemma A, Dereje T (2006) Review on the status of some tropical fruits in Ethiopia. Proceeding of the inaugural and first Ethiopian Horticultural Society conference. Addis Ababa, Ethiopia, pp: 39-44.
9. Fita T (2012) White Mango Scale, Aulacaspis tubercularis, Distribution and Severity Status in East and West Wollega Zones, Western Ethiopia. Sci Technol Arts Res J 3: 01-10.
10. Daneel MS, Dreyer S (1997) Further studies on the establishment Aphytis sp. and Cybocephalus binotatus in mango orchards for the control of the mango scale. Yearbook- South African - Mango Growers Association 17: 144-146.
11. Abo-Shanab AS (2005) Efficacy of some IGR/insecticides, KZ mineral oil and binary mixtures on mortality and enzyme activity of Egyptian mealy bug Icerya aegyptiaca (Douglas) attacked Guava trees in Alexandria Governorate. J Pest Cont Environ Sci 13: 73-85.
12. Kassahun T, Temama H, Sakuja PK (2006) Management of citrus and leaf spot diseases in Ethiopia. Agri Tropica et Subtropica 39: 242-245.
13. Seif AA, Whittle AM (1984) Cercospora fruit and leaf spot of citrus. Annual report of National Horticultural Research Centre Thika, Kenya.
14. Mohammed Y (2007) Distribution and management of Phaeoramularia leaf and fruit spot diseases of citrus in Ethiopia. Fruits 62: 99-106.
15. Pretorius MC, Crous PW, Groenewald JZ, Braun U (2003). Phylogeny of some cercosporoid fungi from Citrus. Sydowia 55: 286-305.
16. Harling R, Shamie IMO, Sesay SS, Kamara AB, Reeder R, et al. (2010) First report of Pseudocercospora angolensis causing leaf and fruit spot of citrus in Sierra Leone. New Diseases Report p: 22.
17. Seif AA (1994) Studies on Phaeoramularia leaf and fruit spot diseases of citrus in Kenya. Ph.D. Thesis, University of Reading, Reading.
18. Seif AA, Hillocks RJ (1998) Some factors affecting infection of citrus by Phaeoramularia angolensis. J Phytopathol 146: 385-391.
19. Dongmo PMJ, Ngoune LT, Dongmo BN, Kuate J, Zollo PHA, et al. (2008) Antifungal potential of Eucalyptus saligna and Eucalyptus camaldulensis essential oils from Cameroon against Phaeoramularia angolensis. Eur J Sci Res 24: 348-357.
20. Wangai AW, Redinbaugh MG, Kinyua ZM, Miano DW, Leley PK, et al. (2012) First Report of Maize chlorotic mottle virus and Maize Lethal Necrosis in Kenya. Plant Disease 96: 1582-1582
21. Adams IP, Miano DW, Kinyua ZM, Wangai A, Kimani E, et al. (2013) Use of next generation sequencing for the identification and characterization of Maize chlorotic mottle virus and Sugarcane mosaic virus causing maize lethal necrosis in Kenya. Plant Pathol 62: 741-749.
22. Nault LR, Styer WE, Coffey ME, Gordon DT, Negi LS, et al. (1978) Transmission of maize chlorotic mottle virus by chrysomelid beetles. Phytopathol 68: 1071-1074.
23. Jiang XQ, Meinke LJ, Wright RJ, Wilkinson DR, Campbell JE (1992) Maize chlorotic mottle virus in Hawaiian-grown maize: vector relations, host range and associated viruses. Crop Protection 11: 248-254.
24. Jensen SG, Wysong DS, Ball EM, Higley PM (1991) Seed transmission of maize chlorotic mottle virus. Plant Disease 75: 497-498.
25. Tsedeke A, Gashawbeza A (1997) Sources of fruit worm resistance in tomato. Pest Management J Ethiopia 1: 1-7.
26. Lietti MM, Botto E, Alzogaray RA (2005) Insecticide Resistance in Argentine populations of Tuta absoluta (Meyrick) (Lepidoptera; Gelechiidae). Neotropical Entomolgy 34: 113-119.
27. Desneux N, Wajnberg E, Wyckhuys KA, Burgio G, Arpaia S, et al. Biological invasion of European tomato crops by Tuta absoluta: ecology, geographic expansion and prospects for biological control. J Pest Sci 83: 197-215.
28. Hayward AC (2000) Ralstonia solanacearum. Encyclopedia of microbiology. Vol. 4, 2nd ed. Academic Press, London.
29. Hepperly P, Zee F, Kai R, Arakawa C, Meisner M, et al. (2004) Producing bacterial wilt-free ginger in greenhouse culture, University of Hawaii, USA.
30. Swanson JK, Yao J, Tans-Kersten JK, Allen C (2005) Behavior of Ralstonia solanacearumracem 3 biovar 2 during latent and active infection of geranium. Phytopathol 95: 136–143.
31. Janse JD (1996) Potato brown rot in Western Europe history, present occurrence and some remarks on possible origin, epidemiology and control strategies. EPPO Bulletin. 26: 679-695.