Pest Incursions Pose a Serious Threat To Food Security and the Kenyan Economy

Macharia I.[1], Koome F.[1], Kosiom T.[1], Munguti F.,[1] Mukoye B.[1], Kimani E[1], Kimenju J.W.[2]
[1] Kenya Plant Health Inspectorate Service (KEPHIS)-P.O BOX 49592, Nairobi

[2] University of Nairobi Faculty of Agriculture, Department of Crop Production and Plant Protection, P.O. Box 29053, Nairobi.

Corresponding Author: macharia.isaac@kephis.org

Abstract

Although Kenya has a well-developed phytosanitary system to regulate introduction of plant and plant products, several pest incursions have been reported in the last two decades. The incursions have culminated in devastating impact on agriculture, biodiversity and the entire Kenyan economy. The objective of this review is to consolidate information on the pests involved, their distribution, estimate the economic losses associated with them and management measures in place. A total of 11 major pests and diseases namely Asian citrus psyllid (ACP), *Bactrocera dorsalis*, Banana xanthomonas wilt (BXW), Cassava brown streak disease (CBSD), Cassava mosaic disease (CMD), Fall army worm (FAW), Maize lethal necrosis disease (MLND), Papaya mealybug (PMB), *Parthenium hysterophorus,* potato cyst nematode (PCN) and tomato leaf miners (*Tuta absoluta*) have been reported in the last two decades. Some of the pests are persistent, invasive, vicious and fast spreading. For instance, the FAW has now spread to nearly all maize growing areas in Kenya in one year after the pest was first reported in 2017. The incursion pests are a major threat to food security, expensive to control and are a barrier to international market access. Integrated measures including improvement of diagnostic potential, increased pest and disease surveillance, improvement in rapid response and pest containment are needed in view of the dangers posed by incursion pests to the entire Kenyan economy whose mainstay is agriculture.

Key words: *Bactrocera dorsalis,* maize lethal necrosis disease, *Parthenium hysterophorus, Tuta absoluta*

Introduction

Agriculture is the backbone of the economies of many African countries contributing over 30% of the GDP. Production has been significantly affected by pest and diseases some of which have been introduced through trade. International movement of plant and plant produce has always been regulated due to the risk of introduction of pests and diseases. As a result of several serious pests having been introduced in different countries in the late 1800s, it was clear that there is need to undertake action to prevent further introductions. For instance, the late blight in Ireland which left over 2 million death due to starvation, the coffee leaf rust in Srinlanka introduced from Africa seriously affected coffee production, In Africa, the outbreak of coconut yellow lethal necrosis in Madagascar, and fusarium wilt of banana caused by strain TR4 in Mozambique are some of the examples of pests which have been reported to cause serious economic damage to the agricultural sector and the environment. Pest incursions has led to development of international phytosanitary measures which are currently being used to prevent introduction of quarantine pests or limit the entry of regulated non-quarantine pests while promoting international trade.

Kenya, like any other African countries has not been spared from the effect of introduction of new harmful pests and diseases. Inadequate phytosanitary capacity in many African countries has been cited as important factors which could be contributing to introduction and spread of new pests and diseases. Additionally, lack of capacity in diagnostics has sometimes delayed responses to emerging and endemic pathogens. Diagnostic tools might be available for some diseases and pests, but may not be applied in time to be effective. The widespread lack of equipment, supplies, reference materials and opportunities for training hamper the

ability of African scientists to provide these basic services and, further, to document the presence of dangerous pathogens and pests within their borders. Globalization, climate change, porous borders, financial constraints, and lack of awareness among farmers, importers, exporters and research scientists have been shown to be a challenge in preventing introduction and spread of harmful pests.

Although Kenya has developed a stringent phytosanitary system which regulates movement of plant and plant products, there has been several pest incursions which have negatively impacted on crop production, biodiversity, and human development. Some of the previous incursions reported before 1998 include Cassava mosaic disease, *Prostephanus truncates* (Larger grain borer-LGB), *Fusarium oxysporum f. sp. cubense* (Panama disease), *Salviniamolesta* (Salvinia) and *Eichhorniacrassipes* (Water hyacinth). These pests are still serious pests in Kenya with enormous resources being channeled to their management .The LGB which is native to Central and South America was introduced in Africa in early 1970s. The pest has spread into Kenya and other African countries through movement of infested grain. Water hyacinth infested Kenyan waterways in mid 1980s. It quickly spread and attained an estimated peak of 17,230 ha coverage on the Kenyan side of the Lake Victoria by 1998.

Foreign pests that have been reported on crops in Kenya since 1998

In the last two decades, Kenya has encountered several major pest incursions which include Asian citrus psyllid (ACP), *Bactrocera dorsalis*, Banana xanthomonas wilt (BXW), Cassava brown streak disease (CBSD), Cassava mosaic disease (CMD), Fall army worm (FAW), Maize lethal necrosis disease (MLND), Papaya mealybug (PMB), *Parthenium hysterophorus,* potato cyst nematode (PCN) and tomato leaf miners (*Tuta absoluta*), among others which have significantly affected food security, the environment and international trade (Table 1). A recent example is the invasive fall army worm which has been extensively damaging on

maize and other crops in Sub-Saharan Africa.

The fall army worm (FAW) *Spodoptera frugiperda*, a native to the tropical regions of the western hemisphere from the United States to Argentina, has caused heavy losses to cereal farmers in Africa since its introduction in the West African region in 2016. FAW was reported for the first time in Kenya in Trans Nzoia County in March 2017 in an offseason irrigated maize crop after which it spread first to all the maize production areas (KARLO, 2017). The pest has continued to cause serious losses in maize production and is threating horticultural export. In view of the importance of this pest, the government has instituted a multi-institutional technical team which has develop strategies for management of the pest.

Maize lethal necrosis is a serious viral disease affecting maize in Kenya. 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 disease was first reported in Bomet County in Kenya in 2011 and is currently spread across several maize production areas (Wangai *et al*., 2012). Estimated maize yield loss due to MLND varies from region to region, maize variety and season of the year. In Kenya, up to 100% yield losses have been reported in areas where the disease was very severe (Wangai *et al*., 2012). MLND causing viruses are transmitted by several vectors including thrips (*Frankliniella Williamsi*), and cereal leaf beetles (*Oulemame lanopus*).The disease is also seed transmitted. Several measures have been put in place to mitigate the negative effect caused by the viruses which include up-scaled seed certification system, use of systemic pesticide and breading for resistance.

Table 1. Foreign pests that have been reported on crops in Kenya since 1998.

Name of pest or disease	Year first reported	Status	Current Distribution	Yield loss Potential	References
Spodoptera frugiperda (Fall army worm)	2017	Widespread	All maize growing areas in Kenya	73%	CABI, 2018
Diaphorina citri (Asian citrus psyllid).	2016	Restricted	Coast Kenya	100% by greening disease	Rwomushana *et al*., 2017
Paracoccus marginatus (Papaya mealybug)	2016	Regulated	Coast Kenya	100%	Macharia *et al*., 2017
Globodera rostochiensis (Potato cyst nematode)	2015	Regulated	Potato production areas	80%	Mwangi *et al*., 2015
Tuta absoluta (Tomato leaf miner)	2014	Widespread	All tomato producing areas in Kenya	100%	Duressa, 2018
Maize lethal necrosis	2011	Regulated	Maize production areas	90%	Wangai *et al*., 2012
Parthenium hysterophorus (Parthenium weed)	2010	Noxious weed	Most open farming lands	High	Guyana, P., & Paraguay, S. 2014
Cassava brown streak disease	2006	Restricted	Coastal and Western Kenya	70%	Were *et al*., 2016
Xanthomonas campestris pv. Musacearum (Banana xanthomonas wilt)	2006	Restricted	Western Kenya	100%	Kwach *et al*., 2013
*Bactrocera (dorsalis) invades(*Mango fruit fly)	2003	Invasive	All host crops producing areas in Kenya	70%	Luc *et al* .,2003; Ekesi *et al*., 2011

Bactrocera dorsalis (formerly *Bactrocera invades*) is an invasive fruit fly species of Asian origin which was first reported in Kenya in 2003 (Lux *et al*., 2003). The pest has been reported to cause yield losses of up to 70% in mangoes (Ekesi e*t al*., 2011). Apart from the huge loss, introduction of *B. dorsalis* significantly affected international market for horticultural produce in Kenya. The most notable example is loss of the European Union (EU) market for mangoes and South Africa market for avocados coupled with inability to access other market such as USA, Australia among others. Use of pheromone traps and post-harvest treatments have been used in the management of the pest (Ekesi *et al.,* 2011)

Banana, a major fruit crop, has been threatened by Xanthomonus Wilt (BXW) caused by a bacterium *Xanthomonas vasicola.pv. musacearum (Xvm)*, formerly known as *Xanthomonas campestris,* which has been shown to cause up to 100% yield loss (Kwach *et al*., 2013). The disease was introduced from Uganda and has been shown to affect all banana cultivars. Xanthomonus Wilt (BXW) is best managed by use of clean planting materials and removing of male flower buds, and sterilization of tools. The disease has been reported in banana growing areas in Western Kenya and Nyanza (Kwach *et al*., 2013).

Tomato (*Lycopersicon esculentum* Mill) is one of the most important vegetable crops whose production has been threatened by *Tuta absoluta* (tomato leaf miner) which was introduced in Kenya in 2014. The pest has been reported to cause yield loss upto100% (Duressa, 2018). Chemical control and use of traps are the main management measures that have been used since the pest was reported.

Cassava Mosaic Disease (CMD) was reported in the 1980 as one of the most important viral disease affecting cassava in Kenya. Despite the effort through breeding for diseases resistance, introduction of cassava brown streak disease (CBSD) in 2006 rendered the effort made futile and breeders were forced to start all over again as all CMD resistant varieties were susceptible to CBSD. CBSD and CMD causing viruses are transmitted by *Bemisia tabaci* and

have the potential of causing up to 100% yield losses. In Kenya, among the CMD causal viruses, EACMV-Ug has recently been reported to be the most prevalent followed by EACMV and ACMV contrary to previous reports where ACMV was the most prevalent in Kenya (Were *et al*., 2016). It is not yet clear what factors have contributed to this change. Breeding for resistance is the most reliable means of control.

Other pest that have been introduced in Kenya include: *P. marginatus,* native of Central America and was first observed on the Africa in Ghana in 2010 from where it spread to other African countries. The pest was reported in Kenya in 2016 (Macharia *et al*., 2017). The pest is highly polyphagous, with hosts recorded from 84 plant species causing yield loss of up to 100%; *Diaphorina citri,* is native in Asia, and was first reported in Kenya in 2016. It causes up to 80% yield loss in citrus (Khan *et al.,* 2014); Potato cyst Nematode (PCN) is a serious pest of potato that was first reported in Kenya in 2014 in most potato production areas (Mwangi *et al*., 2015). Although the pest is native of in Europe, its introduction is still not clear. PCN has been reported to cause yield losses of up to 80%.

Prevention and management strategies of pest incursions in Kenya

Although introduction of pests still remains a challenge in Kenya and other African countries, Kenyan government through KEPHIS and other institutions has invested heavily on technology and policy to support phytosanitary regulation in the effort to prevent pest introduction and spread in the country. Regulating importation of plant and plant product plays an important role in minimizing introduction of harmful pest. Other measures instituted to reduce introduction of pest and diseases includes pest risk analysis which provide risks associated with importation and possible mitigation measures. Pest surveillance to establish occurrence and distribution of pests, pest identification, containment of materials likely to introduce pests in quarantine facilities among others.

KEPHIS Plant Quarantine and Biosecurity Station where most of the plant health facilities are located, is responsible for handling imported high risk plant materials. The imported material are grown under containment and monitored for pests and diseases for a period of time based on the pest before they are released to the importer. This reduces the chances of introduction and spread of harmful pests and diseases in the country. Importers are also allowed to establish quarantine facilities in their farms under strict regulation, monitoring and control from KEPHIS. All materials under quarantine are monitored and tested for quarantine pests before they are released. At the boarder points and point of entry and exit inspection, sampling grading of all imported consignment is undertaken.

In the last two decades several pests were identified in imported materials and appropriate measures undertaken to prevent their introduction. Among the pests detected were coconut case caterpillar *Mahasena corbetti*, *Curtobacterium flaccumfaciens* pv. *flaccumfaciens*, *Pectobacterium spp*, *Dickeya spp*, *Alternaria padwickii*, PVY^{NTN} and several others fungal, bacterial and viral diseases.

Conclusion

Various pest of economic importance have gained entry into the country and are posing as threats to food security and the general well-being of the people. The pests come in the form of plant pathogens, arthropod pests and invasive plant species.

Recommendation

There is need to conduct surveillance in all parts of the country for early detection which is important for management of pests. It is also important to strengthen phytosanitary measures and create awareness on pest management strategies for the county to attain the required food security. A surveillance database for the pests to be updated for ease of retrieval and build up on information.

Acknowledgment

The authors are grateful to the management of The Kenya Plant Health Inspectorate Service and The University of Nairobi for supporting the collaboration that led to this paper.

References

Duressa T. F. (2018). Newly Emerging Insect Pests and Diseases as a Challenge for Growth and Development of Ethiopia: The Case of Western Oromiya*. Journal of the Science of Food and Agriculture* 9, pp. 201.

Ekesi S., De Meyer M., Mohamed S.A., Virgilio M., & Borgemeister C. (2016). Taxonomy, ecology, and management of native and exotic fruit fly species in Africa. *Annual Review of Entomology*. 61, pp. 219–238.

Guyana, P. & Paraguay, S. (2014). Parthenium hysterophorus L. Asteraceae–Parthenium weed. *Bulletin OEPP/EPPO Bulletin*, 44 (3), pp. 474-478.

Khan A. A., Afzal M., Qureshi J.A., Khan A. M. & Raza A. M. (2014). Botanicals, selective insecticides, and predators to control *Diaphorina citri* (Hemiptera: Liviidae) in citrus orchards. *Insect Science.* 21, pp. 717–726.

Kwach J.K., Onyango M.A., Muthomi J.W. & Nderitu J.H. (2013). Status and spread of banana Xanthomonas wilt in Kenya. *African Crop Science Conference Proceedings*. 11, pp. 297-308 .

Lux S, Copeland RS, White IM, Manrakhan A, & Billah MK. (2003). A new invasive fruit fly species from the *Bactrocera dorsalis* (Hendel) group detected in East Africa. *International Journal of Tropical Insect Science* 23, pp. 355–361.

Macharia I., Kimani E., Koome F., Kosiom T., Heya H., Otipa M., & Oronje M. (2017). First Report and Distribution of the Papaya Mealybug, *Paracoccus marginatus*, in Kenya *Journal of Agricultural and Urban Entomology* 33, pp. 142-150.

Mwangi J.M., Kariuki G.M., Waceke J.W., Grundler F.M. (2015). First report of *Globodera rostochiensis* infesting potatoes in Kenya. *New Disease Reports* 31, pp. 18.

Rwomushana I., Khamis F.M., Grout T.G., Mohamed S.A., Sétamou M., Borgemeister C., Heya H.M., Tanga C.M., Nderitu P.W., Seguni Z.S., Materu C.L., & Ekesi S. (2017). Detection of Diaphorina citri Kuwayama (Hemiptera: Liviidae) in Kenya and potential implication for the spread of Huanglongbing disease in East Africa. Biological Invasions.

Smith J.J., Waage J., Woodhall J.W., Bishop J.S., Spence N.J. (2008). The challenge of providing pest diagnostic services for Africa. Eurropean Journal of Plant Pathology. 121, pp. 365-375.

Wangai AW, Redinbaugh MG, Kinyua ZM, Miano DW, Leley PK, Kasina M, Mahuku G, Scheets K, Jeffers D. 2012. First report of Maize chlorotic mottle virus and maize lethal necrosis in Kenya. *Plant Disease*, 96, pp. 1582-1583.

Were M.N., Mukoye B., Osogo A.K., Mangeni B.C., Nyamwamu P. A., Ogemah V. K., Muoma J. V., Winter S., Were H. K. (2016). Occurrence and Distribution of Begomoviruses Infecting Cassava in Western Kenya, *Plant*. 4, pp. 108-113.