International Journal of Research in Agriculture and Forestry
Volume 5, Issue 9, 2018, PP 1-10
ISSN 2394-5907 (Print) & ISSN 2394-5915 (Online)

A Review on Sweet potato (*Ipomea batatas*) Viruses and Associated Diseases

Megersa K.E. Barkessa

Colleges of Agriculture and Veternary Medicine, Jima University, P.O.BOX 307, Jima, Ethiopia

***Corresponding Author:** Megersa K.E. Barkessa, Colleges of Agriculture and Veternary Medicine, Jima University, P.O.BOX 307, Jima, Ethiopia*

ABSTRACT

Sweet potato is among important crops in many African countries including Ethiopia. The production and productivity of this crop is highly constrained by existence of sweet potato viral diseases in Ethiopia. Hence, this review paper was intended to evaluate previous research work concerning to sweet potato viruses and associated diseases as well as their managements emphasizing this country. Accordingly, virus infections are the major economically important there by causing severe disease and threatening sweet potato productivity, especially in major crop producing areas. Totally of ten (10) viruses have been identified and recorded in the country since late 2004 to 2012. Of these viruses SPFMV is the most widespread and damaging followed by SPCSV. The prevalence and incidence of the viral diseases varied from area to area due to environmental variations that affect crop performance and the activity of vectors. Furthermore, the prevalence and incidence of sweet potato viral diseases is high in southern parts of the country. A sweet potato yield reduction of 41-92.6 % has been reported so far due to this disease. Management practices like, cultural, resistant/tolerant varieties, insecticides (to control insect vectors) have been recommended. However, the viruses are causing economic losses with an increasing trend of new virus identification. Hence, due attention should be given by stockholders to strengthen local and national quarantine system as to avoid new virus introduction and dissemination within areas.

***Keywords:** Disease management, Ethiopia, Ipomoa Batatas , Prevalence, Sweet potato viruses*

INTRODUCTION

Sweet potato, Ipomoea batatas (Lam.) is a dicotyledonous plant that belongs to the family Convolvulaceae, and a tuberous root crop important for food security. It is cultivated in over 100 developing countries and ranks among the five most important food crops in over 50 of those countries (FAOSTAT, 2012). Sweet potato is a major crop in most eastern and southern African countries such as Uganda, Rwanda, Kenya, Tanzania, Ethiopia, Zambia, Mozambique and South Africa (FAOSTAT, 2009; Shonga et al., 2013). Plant pathogens including fungi, viruses and bacteria are responsible for increasing economic losses worldwide. Productivity of sweet potato is greatly constrained by pests and diseases that cause yield reduction by up to 98% (Kapinga et al., 2007). Among the sweet potato pests, viruses are the second most important constraint next to sweet potato weevil (Qaim, 1999). Sweet potato viruses are causing a significant problem and economic losses due to crop sensitivity for virus infection. Different yield losses have been reported from different African countries. Nigeria and Uganda account for 50% yield loss. In East Africa, over 90% yield reductions have been associated with viruses (Cohen et al., 1997; Gibson et al., 1998).

In any disease situation it is important to know what virus is causing the problem, where it comes from, and how it spreads before developing control measures (Roger H, 2009). Currently, several sweet potato viruses have been identified and confirmed to be widely distributed in East Africa. These include two that belong to the family Potyviridae: Sweet potato feathery mottle virus (SPFMV, genus Potyvirus) and Sweet potato mild mottle virus (SPMMV, genus Ipomovirus); and the other two that belong to the family Closteroviridae: Sweet potato chlorotic stunt virus (SPCSV, genus Crinivirus) and Sweet potato chloroticfleck virus (SPCFV, genus Carlavirus) (Gibson and Aritua, 2002; Mukasa et al., 2003). In Ethiopia, the first report of a virus on sweet potato in the country was made over two decades ago and proven by electron microscopy examination of sweet potato plants with mosaic symptoms from Adama (Abraham et al., 2010). The virus was identified as SPFMV (SPL, 1986). Subsequently, Alemu (2004) reported a high incidence of SPFMV in some fields and the occurrence of SPVG mainly from Wolayita zone. Currently, high incidence levels of previously identified viruses with recently recorded species have been recorded in sweet potato fields by increasing rate in the country. Moreover, the prevalence of virus disease in sweet potato fields in major crop producing area suggests that the disease has the potential to undermine food security (Tewodros et al., 2011).Even though various management options have been devised to reduce the crop damage and yield losses associated to virus infection, the disease is still threatening the crop productivity in Ethiopia. Hence, there is a need for further research works to address this problem. Generally, to develop any efficient control method, it is a prerequisite to identify gaps and to obtain knowledge of their epidemiological characteristics. Therefore, this review intended to evaluate previous research works for a better understanding of the viruses involved in infection of sweet potatoes in general and in Ethiopia particularly.

Major Viruses And Associated Diseases On Sweet Potato

In total, more than 30 viruses have now been reported to infect sweet potato (Brunt et al., 1996; Clark et al., 2012). The number continues to increase as virus detection methods are improved. Only a few of the viruses are considered to be of major economic importance. These include the Sweet potato feathery mottle virus (SPFMV),Sweet potato chlorotic stunt virus (SPCSV), Sweet potato virus G (SPVG), Sweet potato mild mottle virus (SPMMV), Sweet potato chlorotic fleck virus (SPCFV), Sweet potato latent virus (SPLV), Sweet potato caulimo-like virus (SPCaLV), Cucumber mosaic virus (CMV) and Sweet potato leaf curl virus (SPLCV). Viruses often occur in multiple infections in the field with the most commonly encountered combination being that between SPFMV and SPCSV. This dual infection is responsible for the severe sweet potato virus disease (SPVD) which has been reported to be the major viral disease in East Africa (Chavi et al., 1997; Mukasa et al., 2003). Viruses' infections have considerable effects on cell metabolism such as photosynthesis, respiration, and transpiration. The effects include increasing the activity of some enzymes, decreasing the activity of others, and not affecting the activity of yet others. Symptom induction is primarily by the perturbation of the cell metabolism and damage to cell organelles such as chloroplasts (Roger H, 2009).

In East Africa, severe sweet potato virus disease (SPVD), characterized by small, distorted leaves which are often narrow (strap-like) and wrinkled, with a chlorotic mosaic or vein clearing, stunting of plants and heavy yield losses, has been reported in Uganda since 1944 (Karyeija, et al., 1998 and Mukasa , et al., 2003) and later in Kenya, Tanzania, Rwanda, Burundi, and Malawi (Schaefer and Terry, 1976). Sweet potato virus disease (SPVD) is the most devastating diseases of sweet potato and caused by dual infection with the whitefly-transmitted sweet potato chlorotic stunt virus (SPCSV) and the aphid-transmitted sweet potato feathery mottle virus (SPFMV). Another severe disease is Chlorotic Dwarf (CD) caused by SPFMV, SPCSV and sweet potato mild speckling virus (SPMSV) which occur in numerous countries throughout the world (Tairo, 2006). The overviews of these major sweetpotato viruses are highlighted below.

Mosaic Viruses

This virus was first isolated in Argentina (Nome, 1973). Mosaic is a serious virus disease of sweet potato in the USA, and becoming increasingly serious in Africa (Onwueme, 1978). It is caused by a strain of the tobacco mosaic virus. Infected plants have small, mottled, malformed leaves and yield little or no tubers. Normally, only a few plants are infected in any given field, and it appears that the disease does not spread readily from plant to plant. A simple control measure, therefore, is to rogue and burn the infected plants.

Feathery mottle Virus

Sweet potato feathery mottle virus (SPFMV) is found nearly everywhere sweet potatoes are grown. According to Karyeija, et al (1998) SPFMV is the most important potyviruses infecting sweet potatoes in Africa and elsewhere in the world. It was first isolated from sweet potato and purified by Moyer & Kennedy, (1978). A complex of viruses; the internal cork virus, the leaf spot virus, and the white fly transmitted yellow dwarf virus apparently cause the feathery mottle complex. The white flies concerned are Bemisia and Trialeurodes. These three viruses, when present together, causes severe symptoms which none-of them individually can cause. Feathery mottle disease is characterized by dwarfing of the plants, yellowing of the veins in the younger leaves, and yellowish spotting in older leaves. Internodes are short and tubers are small. Strains of this virus have been shown to be the causal agents to several of the virus diseases of sweet potato (Campbell, et al., 1974; Cadena-Hinojosa & Campbell, 1981; Cali & Moyer, 1981).

Complex Of Viruses

A virus or complex of viruses causes internal cork. It is characterized by the development of corky areas within the flesh of the tuber. These areas remain distinct during cooking and are bitter to the taste. Infected tubers appear normal externally, and the symptoms can only be seen when the tuber is cut. Symptoms on the growing plant include chlorotic leaf spotting, vein clearing and purple ring spotting of the foliage. Various aphids, including the cotton aphid transmit the internal cork virus. Some of the resistant cultivars are symptomless carriers of the virus, and may spread the disease to susceptible cultivars if they are grown close together (Onwueme, 1978). Other viruses of sweet potato include leaf spot, sweet potato vein mosaic virus, sweet potato mild mottle virus, sweet potato latent virus and sweet potato yellow dwarf virus. Three viruses namely SPFMV, SPCSV and SPVG were detected in sweet potato plants Collected from farmers' fields in the main growing areas of Ethiopia. SPFMV is the most widespread followed by SPCSV (Tewodros et al., 2011). These two viruses are the most common and damaging as reported in other East African countries like Uganda, Kenya and Tanzania (Mukasa et al., 2003; Ateka et al., 2004).

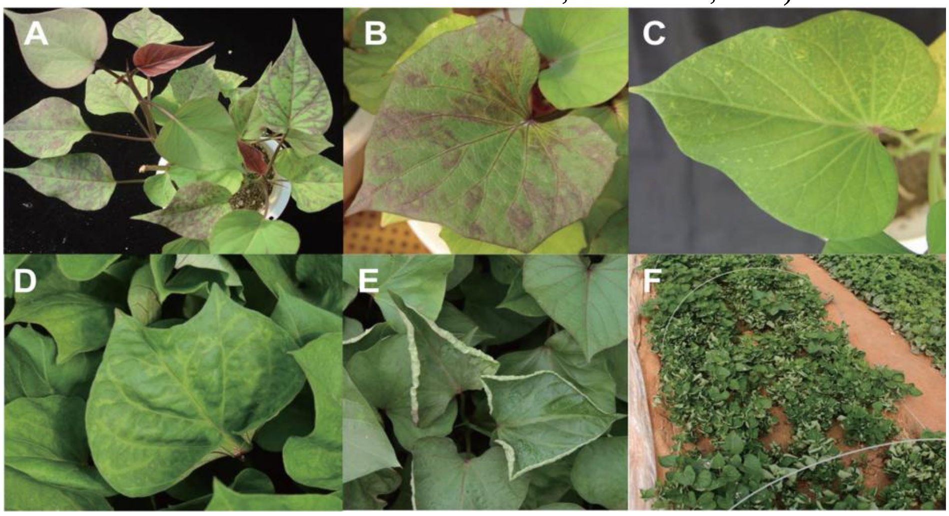


Fig1. *Virus symptoms observed in sweet potato: (A) vein banding and purpling; (B) chlorotic local lesions and purpling; (C) vein clearing and mottle; (D) vein clearing and leaf malformation; (E) leaf curling; (F) leaf curling in a cultivated field.* **Adapted from**: Kwak *et al.*, 2014

Fig2.*The degree of vigor between SPVD, SPVG, SPCSV and SPFMV infected sweet potato plants as compared to the healthy plants, pictures taken in the screen house.* **ADAPTED FROM: Tewodros** *et al*,**2011**

Viral Infection (Translocation)

To induce a disease, the virus must spread throughout and replicate in much of the plant. At this stage, the viral genome and the host genome confront one another, with the virus attempting to establish infection and the host attempting to resist it (Roger H, 2009). Infection processes can be divided in to three phases: Pre-entry, entry and colonization. Phloem transport of plant viruses and setting-up of a complete infection of a host plant. After an initial replication step in the first cells, viruses spread from cell-to-cell through mesophyll cells, until they reach the vasculature where they rapidly move to distant sites to establish the infection of the whole plant (Clémence H. et al., 2013). The last step is referred to as systemic transport, or long-distance movement, and involves virus crossings through several cellular barriers: bundle sheath, vascular parenchyma, and companion cells for virus loading into sieve elements (SE). Viruses are then passively transported within the source-to-sink flow of photo assimilates and are unloaded from SE into sink tissues. While most viruses seem to move systemically as virus particles, some viruses are transported in SE as viral ribonucleoprotein complexes(RNP). Then, viral transport complexes move from cell-to-cell and on-going replication takes place in the newly infected cells (Figure 3) below. This short-distance movement requires modification of plasmodesmata (PD) by viral movement proteins (MP; reviewed by Schoelz et al., 2011). To carry out cell-to-cell and long-distance movements, viruses take advantage of plant existing transport routes, including PD and phloem vasculature, and follow the source-to-sink transportation of carbohydrates (Maule, 1991; Carrington et al., 1996).

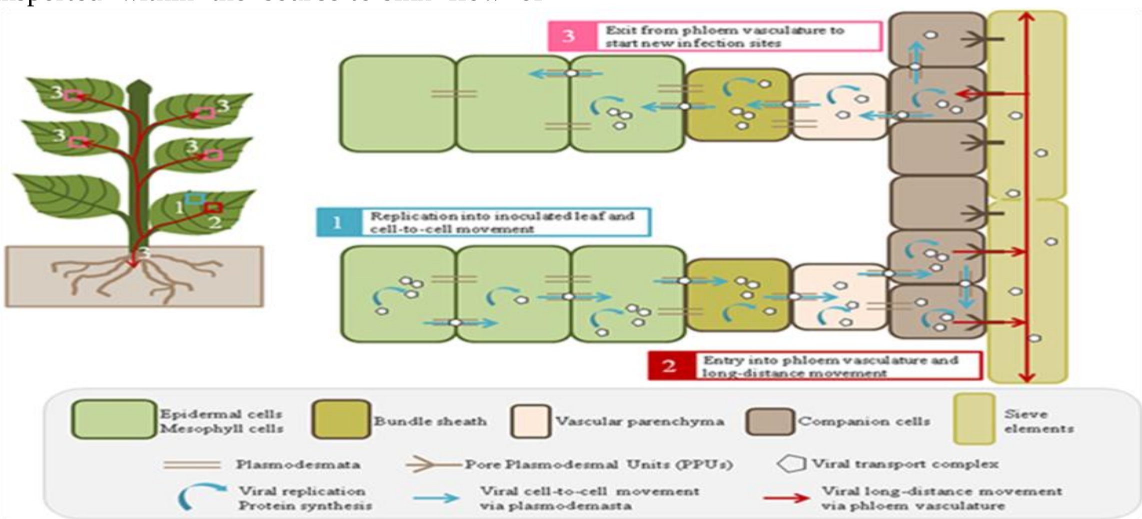


Fig3. *A general view of virus cell-to-cell and long-distance movement in plant tissues*

Source: *Clémence H. et al., 2013.*

Primary Source And Transmission Of Viral Diseases

The viral diseases are developed from different sources and transmitted from there. Infected seed source; since sweet potatoes are reproduced vegetatively, exotic viruses infecting the crop can result in epidemics (MOYER, 1987). Such an increase of viruses in sweet potato planting material through time has been well documented (ONWUEME and CHARLES, 1994; KARYEIJA et al, 1998b). Hence, rapid detection of exotic and identification of endemic viruses is vital in the prevention of viral out-breaks. Infected cuttings contributing to spread of these viruses; since these plants resembled healthy ones, farmers may not be able to distinguish and exclude such infected cuttings from the planting materials they select for the next crop, thus contributing to spread of these viruses. Some of the resistant cultivars are symptomless carriers of the virus, and may spread the disease to susceptible cultivars Gardens as planting materials, and without sanitary control facilitate spread of the disease. Consecutive use of potato tubers caused the accumulation of virus and could cause degeneration of seeds (Mesfin et al., 2009).

Being obligate parasites, viruses depend for survival on being able to spread from one susceptible individual to another fairly frequently. Plant viruses must cross two barriers the cuticle and the cell wall before they can infect a plant; this is done by mechanical damage. The plant virus can be introduced either from plant material or by a biological vector. Introduction from plant material can be by mechanical damage (e.g., breaking leaf hairs), through seed or pollen, or by grafting or vegetative propagation whereas biological vectors are invertebrates (arthropods or nematodes) and fungi and protests (Roger H, 2009).Plant viruses are also transmitted from plant to plant in a number of ways. Modes of transmission include vegetative propagation, mechanically through sap, through seed, pollen, dodder, and by specific insects, mites, nematodes, and fungi (Agrios, G.N. 2005).Diseases can be transmitted through the aphid and whitefly vectors of the viruses thereby resulting in higher disease incidence as suggested by Aritua et al. (1998). Various thrips are also involved in transmitted the diseases According to Tesfaye et al. (2013) in Southern Region of Ethiopia (SNNPR), vector insect pests such as sweet potato aphids and white fly were documented. Both of these insect pests were already known vectors of sweetpotato viral diseases (SPVD).

Occurrence And Distribution In Ethiopia

Sweet Potato Viruses Diseases Recorded So Far

Viral diseases are considered as major constraint for production and productivity of the crop in In recent years, there have been reports of increasing importance of sweet potato virus diseases. The movements of infected planting materials are the main mode for the long distance dissemination of plant pathogens, as locally spread mainly by cultural practices and vectors. This means led authors to suspect that SPVD is introduced into SNNPR through planting materials form east Africa, likely from Uganda; as this country is the main partner for the new germplasm/planting materials introduction. The subsequent dissemination of

Ethiopia. In recent years, there have been reports of increasing importance of sweet potato virus diseases. Different viral diseases have been recorded in the country (Table 1).The presence of sweet potato virus in Ethiopia was first reported by scientific Phytopathological Laboratory in 1986 and identified as Sweet potato feathery mottle virus (SPFMV) (SPL, 1986). It has been reported in Ethiopia in 1986 (SPL, 1986). However, the disease had not been a limiting factor in sweetpotato production and productivity until 2004. Lately, Alemu (2004) conducted a survey and confirmed the presence of SPFMV and another virus, namely, Sweetpotato virus G (SPVG) mainly from Wolayita and Sidama zones of the country through serological test using antiserum in DAS-ELISA. Subsequent studies have been indicated high incidence and occurrence of SPFMV, Sweetpotato virus G (SPVG), Sweet potato chlorotic stunt virus (SPCSV) and Sweetpotato virus 2 (SPV2) in the country in infecting the crop either singly or in combination (Alemu T, 2004; Abraham A, 2010; Tewodros T. et al., 2011).

disease within the region is also mainly through cuttings (infected planting materials) distributions (Tesfaye et al., 2013). According to Shiferaw M. et al., (2016), in addition to the previously identified ones, (SPFMV, SPCSV & SPVG) (SPL, 1986; Alemu T, 2004), more new viruses such as C-6 virus, Sweetpotato caulimo-like virus (SPCaLV), Sweetpotato chlorotic flecks virus (SPCFV), Sweetpotato mild speckling virus (SPMSV), Cucumber Mosaic Virus (CMV) and Sweetpotato latent virus (SwPLV) were detected.

Table 1. *Sweetpotato Viral diseases recorded so far in Ethiopia*

Diseases	Scientific Name	References
SPFMV	Poty virus	SPL (1986) and Tamru (2004)
SPVG	Poty virus	Tamru (2004)
SPCSV	Crini virus	Abreham (2010)
SPV2	Poty virus	Abreham (2010)
SPVD ((SPCSV+SPFMV))	Crinivirus + Poty virus	Abrham (2010) and Tamru (2006)
C-6 virus		Anonymous (2012)
SPCaLV		Anonymous (2012)
SPCFV	Carla virus	Anonymous (2012)
SPLV	Poty virus	Anonymous (2012)
SPMSV	Poty virus	Anonymous (2012)
CMV	Cucumo virus	Anonymous (2012)

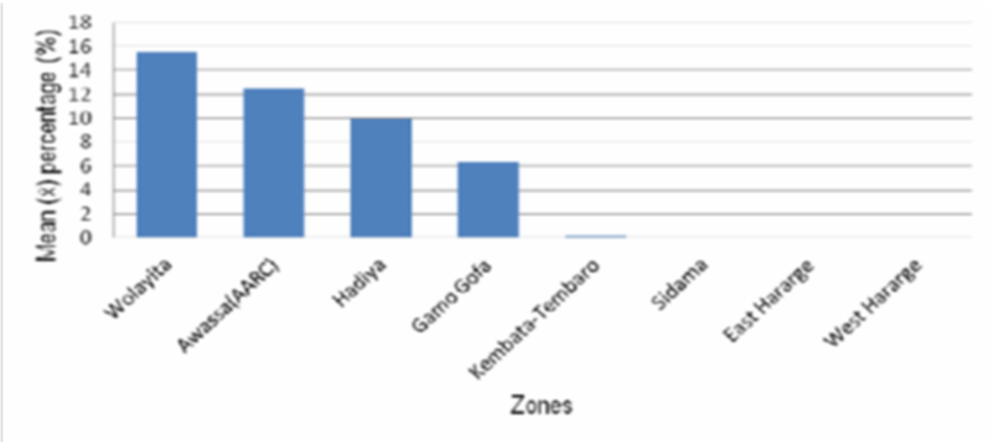
Source*: Shiferaw et al., 2014*

Diseases Incidence And Prevalence

In Ethiopia, the prevalence and incidence of viral diseases vary from one area to another area or field to field due to various factors.

According to Tewodros et al., (2011), compared to the cooler, wet, higher altitude areas of Eastern Ethiopia, Southern Ethiopia is in the lower altitude, warmer and drier climate which may have favored a higher population of the aphid and whitefly vectors of the viruses thereby resulting in higher disease incidence as suggested by Aritua et al. (1998). The authors also reported a high prevalence of virus diseases in farmers' fields in southern Ethiopia and a low prevalence in Eastern Ethiopia. However, the prevalence was varied from zone to zone within the study areas in both Eastern and southern parts of the country (Figure 4) below. Accordingly, the average prevalence of virus and virus-like symptom were 15.6% in Wolayita, 12.5% at Awassa (AARC), 10% in Hadiya, 6.3% in Gamo Gofa, 0.15% in Kembata-Tembaro, 0.1% in Sidama and 0.03% in East Hararge. The most prevalent virus was SPFMV (15.1%) followed by SPCSV (12.9 %) and SPVG (4.5 %).

Mixed infection of SPFMV + SPCSV was the most common co-infection observed (9.3%) followed by SPVG+SPCSV (3%) of the samples assessed whereas no virus was detected in any of the samples obtained from Eastern and Western Hararge zones (Figure 4). Moreover, it has been reported that both SPFMV and SPCSV, the component of devastating SPVD, are prevalent in most zones of southern ethipoia whereas SPVG has a narrow distribution and was rarely encountered (Tewodros et al., 2011).



In SNNPRS, widespread of viral infection and severity on sweetpotato was observed from 2006-2009 in both research and farmers' fields, which also resulted in the reduced production and productivity of the crop (Abrham, 2010). Tewodros et al. (2011) reported the distribution of the disease in Southern region with incidences ranging from 20-100% and 8.3-30% in the symptomatic and asymptomatic samples, respectively (Figure 5). Alemu (2004) also reported a high incidence of SPFMV in some fields and the occurrence of another virus named SPVG mainly from Wolayita and Awassa areas. However, the report concluded that the absent SPVD in the country was SPCSV. On the other hand, Abraham (2010) reported a highprevalence of both SPFMV and SPCSV in research fields at Awassa and Wondo Genet.

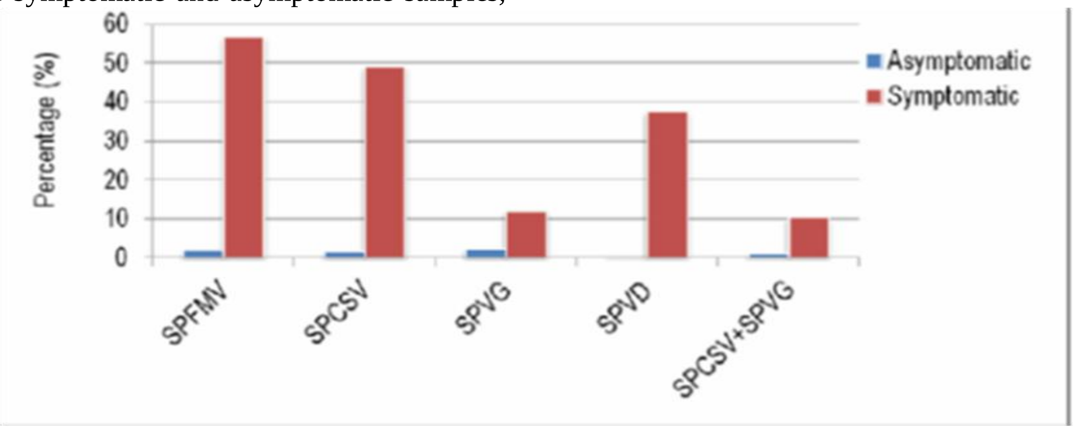


Fig5. *Prevalence of single and dual virus infections detected using NCM-ELISA assay in sweet potato samples from Ethiopia* **source:** Tewodros T. *et al* .2011.

According to Tesfaye et al. (2013), in SNNPR, of the samples collected from both on farm and research station, the prevalence and distribution of SPVD was highest in experimental stations than in farmers' fields. On the other hand, it is distributed almost in all assessed location of

SNNPR with varying level of incidences. Accordingly, the highest SPVD incidence was observed in Hawassa Agricultural Research Center followed by kembata and wolaita zones on-farm trial (100%, 75%, 66.7%) respectively. Whereas at Wolaita and Sidama zones sub research centers a virus incidence of about 37.30% 40%, respectively were recorded. At the course of survey, Amaro on farm the crop was free of SPVD incidence (Table 2) below.

Table 2: *Sweet potato virus disease incidence and distribution in major sweet potato*

Location	**Sweet potato virus disease incidence**			**Remark**
	On farm (%)	**On station (%)**	**Laboratory test**	
Sidama	37.30	100	+	
Gedeo	25.00	-	+	-No testing site
Amaro	0.00	62.20	+	
Wolaita	66.70	-	+	No crop at the time
GamoGofa	40.00	46.70	+	
Kembata Tembaro	75.00	-	+	- No testing site

Adapted from: *Tesfaye et al. (2013)*

Damage And Losses In Ethiopia

Sweet potato virus disease (SPVD) is currently threatening sweet potato production in Ethiopia than ever, with more viruses unidentified earlier being detected in more recent years (Shiferaw M. et al., 2016). The importance of diseases becomes paramount because the crop is highly sensitive to virus infection (Teddy et al., 2011). SPVD is became the important and serious problem of sweetpotato production causes considerable yield losses in Ethiopia. Previous studies have indicated that the yield loss due to virus infection vary from 50- 100% in different countries. On the other hand Tesfaye et al. (2013) reported the average reduction in number of roots and weight (kg) of roots was ranged from 24.58 to 63.60 and 9.76 to 59.62 percent per plant, respectively due to the virus disease infection in in major sweet potato growing areas, SNNPR, Ethiopia. By the same assessment the authors also demonstrated the mean reduction in number of roots of 44.73% and weight (kg) of roots of 32.44% per plant was recorded % though the systematic yield loss was not yet assessed adequately (Table 3) below.

Table 3.*Effect of virus disease on the yield in major sweet potato growing area, SNNPR*

Location	**Healthy**		**Diseased**		**Reduction(%) in**	
	Average No.of root/plant	**Average Weight of root/Plant(kg)**	**Average No.of root/plant**	**Average Weight of root /Plant (kg)**	**Root**	**Weight**
Sidama	4.6	0.45	. 2.24	0.13	48.5	28.9
Gedeo	5.1	0.36	1.85	0.17	36.3	47.2
Amaro	4.5	0.52	2.83	0.31	63.6	59.6
Wolaita	5.2	0.51	2.11	0.05	40.9	9.8
GamoGofa	4.8	0.55	2.62	0.27	54.6	49.1
Kembata	4.8	0.41	1.17	0.04	24.6	9.8
Mean	**4.8**	**0.46**	**2.13**	**0.16**	**44.7**	**32.4**

Adapted from: *Tesfaye et al. 2013*

According to Mesfin et al. (2009) it has been reported that continuous cultivation of potato varieties using seeds from previous season, 41-62% yield reduction was recorded after four years depending on the relative tolerance of each variety which mainly due to the accumulation of virus that could cause degeneration of seeds. In Ethiopia, the root yield reduction due to the synergistic infection of SPFMV and SPCSV was reported to be 37% (Tesfaye et al., 2013). According to Shiferaw M. et al. (2016), in research plots difference has been observed for virus disease severity and storage root yield among sweet potato genotypes indicating the possibility of selection for resistant /tolerant/ clones against sweet potato virus disease. Moreover, within virus susceptible genotypes, 47.8% – 92.6% yield reduction was witnessed in the third year of the experimental period.

Management Practices

Currently, several sweet potato viruses have been identified and confirmed to cause diseases either in single or dual infection. The diseases are causing severe sweet potato yield losses worldwide. Although control of viral diseases remains difficult in subsistence cropping systems (Rukarwa et al., 2010), disease management strategies such as cultural practices, phytosanitary measures, control of vectors and deployment of genetic resistance to prevent or limit the extent of damage have been recommended (Maule et al., 2007; Van den Bosch et al., 2007). Among these, use of disease resistant plants are ideal in terms of effectiveness and sustainability for managing any plant disease in general and SPVD in particular (Okada et al., 2001; Valverde et al., 2007; Maule et al., 2007). The use of sweet potato resistant varieties to reduce the impact of SPVD under farmer's field were reported earlier (Mianoet et al., 2008).

In Ethiopia different management practices including, the use of resistance/ tolerant varieties integrating with selection of healthy vines, timely removal of SPVD infected plants (to prevent further spread of virus by vectors) and establishment of isolated sites/nurseries (for virus free planting materials production) and control of vectors have been used in major sweet potato growing areas of Ethiopia (Tesfaye et al., 2013). Prevention of the virus from getting established in the areas where currently not affected and/ or little affected is among the option of its management (Tesfaye et al., 2013; Tewodros T. et al., 2011). In order to manage these threatening diseases, it is also recommended to strengthen local quarantine system, training of farmers, experts and multipliers (Tewodros T. et al., 2011).Similarly, cultural practices like, cropping system /crop rotation, removal and burning of the infected plant and virus free Seed sources (Abraham A., 2010); it is also have been suggested to clean and distribute virus free planting materials to reduce the present status of the disease and its effect on the resource poor farmers and multipliers (Shiferaw M. et al., 2014; Tesfaye et al., 2013).Application of the combination of all the compatible practices is necessary for sustainable diseases management.

CONCLUSION AND FUTURE LINE WORK

Different viruses can involve in causing diseases in sweet potato around the globe. Various yield losses have been reported from different areas mainly of African countries. Currently, in Ethiopia the prevelence of virus disease in sweet potato fields is increasing, especially in major growing areas. The increment in prevalence suggests that the disease has the potential to undermine food security in the areas. Hence, any future management attempts should concentrate on viruses. Moreover, urgent measures to stop their further spread across and/ within country (Ethiopia). Similarly, there is a need for introducing internal quarantine to minimize the movement of virus-infected from other countries to Ethiopia in near future. Prevention of the virus from getting established in the areas where currently not affected and/ or little affected is also among the option of its management. Application of the combination of all the compatible practices is necessary for sustainable diseases management.

Screening new insecticides to control vectors of viruses. Additionally, awareness creation of development workers and farmers on the importance of SPVD through continuous training is very essential.

REFERENCES

[1] Abraham A, 2010. Associated viruses threatening sweet potato improvement and production in Ethiopia. African crop science journal 18, 207 – 213.

[2] Agrios, G.N. 2005. Plant Pathology 5th Edition. Academic Press, San Diego, CA.

[3] Alemu T, 2004. Characterization of Viruses of Pepper (Capsicum spp.) and Sweet Potato (Ipomea batatas) from Ethiopia. Doctoral Dissertation. University of Bonn. pp. 126.

[4] Aritua V, Adipala E, Carey EE, Gibson RW, 1998. The Incidence of Sweet Potato Virus Disease and Virus Resistance of Sweet Potato Grown in Uganda. Annals of Applied Biology 132, 399-411.

[5] Ateka ME, Njeru WR, Kibaru GA, Kimenju JW, Barg E, Gibson WR, Vetten JH, 2005. Identification and Distribution of Viruses Infecting Sweet Potato in Kenya. Annals of Applied Biology 144, 371–379.

[6] Brunt, A. A., Crabtree, K., Dallwitz, M. J., Gibbs, A. J. and Watson, L. 1996. Viruses of Plants. Descriptions and Lists from the VIDE Database. CAB International, Wallingford, UK.

[7] CADENA-HINOJOSA, M.N. & CAMPBELL, R.N., 1981. Characterization of isolates of four aphid-transmitted sweet potato viruses. Phytopathology 71, 1086.

[8] CALI, B.B & MOYER, J.W., 1981. Purification, serology and morphology of two russet crack strains of sweet potato feather mottle virus. Phytopathology 71, 302-305.

[9] CAMPBELL, R.N., HALL, D.H. & MIELINIS, N.M., 1974. Etiology of sweet potato rusts crack disease. Phytopathology 64, 210.

[10] Chavi F, Robertson AL, Verduin BJM, 1997. Survey and Characterization of Viruses in Sweet Potato from Zimbabwe. Plant Disease 81, 1115-1122.

[11] Clark, C. A., Davis, J. A., Abad, J. A., Cuellar, W. J., Fuentes, S., Kreuze, J. F., Gibson, R. W.,

Mukasa, S. B., Tugume, A. K., Tairo, F. and Valkonen, J. P. T. 2012. Sweetpotato viruses: 15 years of progress on understanding and managing complex diseases. Plant Diseases 96, 168-185.

[12] Cohen L, Milgram M, Antignus Y, Pearlsman M,Lachman O, Loebestein G, 1997. Ipomoea Crinkle Leaf Curl caused by a Whitefly-Transmitted Gemini-Like Virus. Annals of Applied Biology 131, 273-282.

[13] FAO STAT. 2009. FAO Statistics. http://faostat.fao.org/site/567/default.aspx#ancor

[14] Fuglie KO, 2007. Priorities for Sweet Potato Research in Developing Countries: Results of a Survey. HortScience 42, 1200–1206.

[15] Gibson RW. and Aritua V, 2002. The Perspective of Sweet Potato Chlorotic Stunt Virus in Sweetpotato Production in Africa: A review. African Crop Science 10, 281-310.

[16] Gibson RW, Mpembe I, Alicai T, Carey EE, Mwanga ROM, Seal SK, Vetten HF, 1998. Symptoms, Aetiology and Serological Analysis of Sweet Potato Virus Disease in Uganda. Plant Pathology 47, 95-102.

[17] Karyeija RF, Gibson RW, Valkonene JPT, 1998. The significance of sweetpotato feathery mottle virus in subsistence sweetpotato production in Africa. Plant Disease vol. 82, 4-15.

[18] Kwak, H. R., Kim, M. K., Nam, M., Kim, J. S., Kim, K. H., Cha, B. and Choi, H. S. 2014. The Current Incidence of Viral Disease in Korean Sweet Potatoes and Development of Multiplex RT-PCR Assays for Simultaneous Detection of Eight Sweet Potato Viruses. Plant Pathol. J 30 (4), 416-424.

[19] Maule, A.J. Caranta, C. and Boulton, MT. 2007. Sources of natural resistance to plant virus: status and prospects. Molecular plant pathology 223-231

[20] Mesfin, T. Wondirad, M. and Bekele, K. 2007. Review of Research on Diseases of Root and Tuber Crops in Ethiopia In. Abraham. T, eds: Increasing Crop Production through Improved Plant Protection Volume II. Plant Protection Society of Ethiopia (PPSE). Ethiopian Institute of Agricultural Research (EIAR), Addis Ababa, Ethiopia. Volume II. 169-202.

[21] Miano, D., Labonte D, Clark C. 2008. Identification of molecular markers associated with sweetpotato resistance to sweetpotato virus disease in Kenya. Euphytica 160, 15-24.

[22] MOYER, J.W. & KENNEDY, G.G., 1978. Purification and properties of sweet potato feathery mottle virus. Phytopathology 68, 998-1004.

[23] Mukasa SB, Rubaihayo PR, Valkonen JPT, 2003. Incidence of Viruses and Virus-like Diseases in Sweet Potato in Uganda. Plant Disease 87, 336-340.

[24] Kapinga R, Ndunguru J, Sseruwagi P, Sayi B, Mwanga R, Tumwegamire S, Rugutu C, 2009. Assessing the Sweet Potato Virus Disease and its Associated Vectors in Northwestern Tanzania and Central Uganda. Africa Journal of Agricultural Research 4, 334-343.

[25] Ndunguru J. and Kapinga R, 2007. Viruses and Virus- Like Diseases Affecting Sweet Potato Subsistence Farming in Southern Tanzania. Africa Journal of Agricultural Research 2, 232-239.

[26] NOME, S.F., 1973. Sweet potato vein mosaic virus in Argentina. Phytopathology 77, 44-49.

[27] ONWUEME, I.C., 1978. The tropical tuber crops. Yam, Cassava, Sweet potato and Cocoyams. New York: John Wiley & Sons.

[28] Qaim, M. 1999. The Economic Effects of Genetically Modified Orphan Commodities: Projections for Sweetpotato in Kenya. ISAAA brief No. 13 – 19.

[29] Roger. H. 2009. Comparative Plant Virology 2nd Edition, Academic Press, San Diego, CA.

[30] Shiferaw M., Berhanu B., Tesfaye T. and Fekadu G. 2016. Evaluation of exotic and locally adapted sweet potato cultivars to major viruses in Ethiopia. Greener Journal of Agricultural Sciences 6(2), 069-078

[31] Shiferaw Mekonen, Fikre Handoro, Fekadu Gurmu, Elias Urage 2014. Sweetpotato Diseases Research in Ethiopia. International Journal of Agriculture Innovations and Research Volume 2 (6), 932-938.

[32] Shonga, E., M. Gemu, T. Tadesse and E. Urage. 2013. Review of entomological research on Sweet potato in Ethiopia. Discourse Journal of Agriculture and Food Sciences. Vol 1(5), 83-92.

[33] SPL (Scientific Phytopathological Laboratory). 1986. Progress Report for the Period 1985/86, pp. 252-259. Ambo, Ethiopia.

[34] [34] Tairo F. 2006. Molecular resolution of genetic variability of major sweetpotato viruses and improved diagnosis of poty viruses co-infecting sweetpotato. Doctoral diss. Dept. of Plant Biology and Forestry Genetics, SLU. Acta Universitatis agriculturae Sueciae.

[35] Tesfaye, T., Fikre, H. and Mesele, G. 2013. Prevalence, incidence and distribution of sweet potao virus: Its effect on the yield of sweet potato in Southern Region of Ethiopia. International Jurnal of Science and research Volume II (1), 591-595.

[36] Tewodros, T., Tielye, F. and Adane A. 2011. Survey and serological detection of sweet potato Ipomoe batatas (L) am.) Viruses in

Ethiopia. Journal of Applied Biosciences vol. 41, 2746 -2756.

[37] Valverde, R.A., Clark, C.A. and Valkonen JPT 2007.Viruses and virus disease, complexes of sweet potato. Plant Virus. 1, 116-126.

[38] Van Den Bosch, F., Jeger, M. and Gilligan, C. 2007. Disease control and its selection for damaging plant virus strains in vegetative propagated staple food crops. Proc. Royal Soc. B: Biol. Sci. 274:11.

Citation: *Megersa K.E. Barkessa.(2018). "A Review on Sweet potato (Ipomea batatas) Viruses and Associated Diseases". International Journal of Research in Agriculture and Forestry, 5(9), pp.1-10.*

Copyright: *© 2018 Megersa K.E. Barkessa. 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.*