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Affected, Dispersal, Impacts and Evaluation of Resistance Reaction of maize streak virus. A Mini Review

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Abstract

Maize streak virus (MSV) has deleterious effects on maize production in tropical and sub-tropical Africa. The disease is transmitted persistently by several species of leafhoppers, *Cicadulin* spp. (Homoptera: Cicadellidae). Therefore, it is prudent to mitigate the control of MSV is most effective when cultural and chemical methods are integrated with plant breeding for resistance. While host plant resistance is the best method of MSV management, it is not usually easy to conventionally produce resistant cultivars. This paper reviews the distribution, host/species affected, dispersal, impact and information evaluation of improved maize varieties. This review aims to address successful breeding strategies regarding maize streak virus resistance. Resistant cultivars are important to control maize streak virus since they do not present additional costs for the farmer, do not harm the environment and reduce costs of seed production.

Keywords: *Cicadulina, maize streak, improved maize, integrated disease management*

Introduction

Maize (Zea mays L.) is world's third most important cereal food crop next to wheat and rice in the world economy and the second most food consumption next to wheat globally (Maazou et al., 2013). It is as well the most important among cereals providing food and income in Sub-Saharan African (SSA) countries including Ethiopia (Abera et al., 2013). In Ethiopia, maize is a vital multipurpose crop that is ranking first in total production and yield among the cereals (CSA, 2001). Moreover, maize has also is a vital commodity and greatly contributes more than 75% of its national production are coverage supplied daily calorie intake for millions of the inhabitants in Ethiopia, East Africa (Gemechu et al., 2016). The CSA (2020) report revealed that from the total grain crop area coverage, 81.46% was covered by cereals of which maize accounted 21.7% and 32.5% while tef recorded 24.1 % and 17.2% for both area coverage and grain production respectively in Ethiopia. Maize crop grows in Ethiopia among six traditional zone exist in woina dega (mild-altitude agro ecology zone 1500-2300 m.a.s.l). The crop is the most dominant crop among cereal crops providing 4.3 t /ha average grain yield and greater than the national average yield (4.24 t/ha) of the country (Yaregal et al., 2021).

Maize production and productivity in Ethiopia remains low due to a number of biotic and biotic factors. A variety of biotic stresses, such as disease incidence, insects/pests, and weed problems like Striga spp., are common in tropical maize-growing areas (Keerthana et al., 2023). poor soil fertility with low P and N, high or low temperature, salinity, drought or flooding, metal toxicity are a few of the major abiotic stress conditions a plant faces daily during its life cycle (Chen et al., 2013; Ingram,2011; Morand et al., 2012)

Several diseases damage the maize crop soon after planting to maturity and causes severe losses to the crop. The three main tropical maize viruses are: maize streak virus (MSV), maize stripe virus (MStpV) and maize mosaic virus (MMV). The endemic nature of some viral diseases of maize is one of the major factors responsible for low productivity (Thottappilly et al., 1993)

About 32 viruses infect maize; however, only 7 have been reported in SSA and among these, maize streak virus (MSV), genus Maize streak virus in the family Gemini viridae is one of the top ten economically important plant viruses (Brunt et al., 1990; Rybicki,2015; Daniel et al., 2012). maize streak virus (MSV) that belongs to the family Gemini viridae and

a well-known member of the genus Maize streak virus implicated in the maize streak virus disease (MSVD). The virus possesses a single component of circular, single-stranded DNA genome of about 2700 bases encapsulated in germinate particles (Redinbaugh and Zambrano,2014) and is persistently transmitted by a leafhopper of the Genus Cicadulina (Family *Cicadellidae*, Order Hemiptera), which is a migratory vector. MSV infects maize and some other members of the family Gramineae only on the African continent and adjacent islands. Shepherd et al., (2010) reported the serious impact of foliar diseases on the production and productivity of maize in East Africa.

Genetic resistance of crop plants to infection by the pathogen is a safe alternative and most economical and eco-friendly disease management venture. The resistant varieties are not only environmentally friendly but also suitable to adopt at farmer's level. Keeping the above points in mind, introducing available control measures to the farmers is vital to increase production and productivity in maize growing areas. hereafter, this article seriously review effort was made for development of resistance against maize streak virus disease had large effect on the maize crop improvement which would be useful further in improvement of maize populations through population improvement programs.

Maize streak virus Distribution

MSD, first described by Fuller over a century ago in South Africa, occurs throughout sub-Saharan Africa and its neighboring islands (Bock,1974; Rose, 1978). Maize streak virus is widespread in tropical and sub-tropical Africa causing up to US$480 million losses annually (Indiada et a., 2006; Magenya et a., 2008) where it manifests from sea level to 2000 m above sea level (Welz et al., 1998). MSV is indigenous to Africa, including the adjacent Indian Ocean Islands of Reunion, Mauritius and Madagascar (Willment et al., 2001). The first record of MSD was by (Fuller,1901) in South Africa's Natal province (now KwaZulu-Natal) citied by (Shepherd et al., 2007). Serious MSV epidemics have been reported in at least 20 African countries including Angola, Benin, Burkina Faso, Cameroon, Democratic Republic of Congo, Ghana, Kenya, Malawi, Mozambique, Nigeria, Zambia and Zimbabwe (Wambugu and Watula,2000; Magenya et al., 2008).

Result of preliminary survey was made in the most important maize-growing regions of Ethiopia indicated that five species of *Cicadulina* were found, including two not previously reported from Ethiopia.

The maize strain of maize streak geminivirus (MSV) occurred predominantly between 450 and 1800 m above sea level, which coincides with the altitudinal range of *C. mbila* implicating this species as the principal vector of MSV in Ethiopia. The maize strain isolate was indistinguishable from others from elsewhere in Africa (Mesfin et al., 2008). Based on the results of surveys were conducted during the 2019 main cropping season in different agro-ecological zones of Gambela, Benishangul-Gumez and Oromia regions showed that maize streak virus (MS) is an economic disease of maize at low and mid altitude growing areas (Redinbaogh and Zambrano,2014).

Hosts/Species Affected

Maize streak virus infects cultivated crops include: maize, rice, wheat, oats, barley, rye, finger millet, sorghum, and sugarcane, while the affected wild grass species belong to the following genera: Sporobolus, Eleusine, Paspalum, Brachiara, Imperata, Rottboelia, Dactylocterium, Eragrostis, Diplachne, Leptochloa, Setaria, Tragus, Euchlanaena and Coix (Markam et al., 1984; Mesfin et al., 1995; Bosue-Perez ,2000; Bierre et al., 2001).

Dispersal MSV

Maize Streak virus is transmitted by insect leafhopper vectors in the genus *Cicadulina*, where it is the most important in the epidemiology of the virus. According to Food and Agriculture Organization (FAO), 18 species of Cicadulina leafhoppers, from 22 species already globally reported in FAO, are found in Africa (Alemeh et al., 2021). Several leafhopper species have been identified as vectors of MSV in nature (Brunte et al., 1990) including: *Cicadulina mbila*, C. *arachidis*, C. *bipunctella*, C. *triangula*, C. *bimaculata*, C. *similis*, C. *latens*, C. *ghaurii* and C. *parazeae*.

Impact

The maize streak virus impact is high when plants that were infected at an early stage 33-56% (Rossel and Thottappilly,1985). Wheras, in Mauritius yield losses of 24 to 48% were reported in the mid-1970s. Outbreaks of the disease associated with drought conditions or uneven rains. MSV disease decreased yield of resistant variety by 1.5%, and of moderately resistant by 17% (Bosgue-Perez et al., 1998).

Lukuyu et al., (2002) Reported farmers' loss up to Ksh 28,000/ha (£ 800/ha) due to effect of early infection when they plant maize streak virus disease susceptible cultivar in Kenya. Infection of a maize crop in the first three weeks of planting often results in 100% yield loss (Buddenh et al., 1999).

Information Evaluation of Resistance Reaction of Maize Streak Virus

The control of MSV is most effective when cultural, chemical methods and integrated with plant breeding for resistance. Produced successfully method-resistant maize varieties against MSV is Genetic engineering. the best method. Though, by most African countries opponents of use of genetic engineering have prohibited the adoption of the technology. This means that smallholder farmers have to continue growing susceptible cultivars or buy the slightly more expensive conventionally bred (Charles,2014).

Trial in 2001 and 2002 Six improved maize varieties and one check entry were evaluated at South western Nigeria for yield performance, disease reaction and adaptation and result revealed that the improved maize varieties tested were generally suitable for south western Nigeria. They were equally fairly resistant to the prevailing diseases of the region. Varieties such as DMR-ES R-W and EV8443DMR-SR that appears to be sensitive to seasonal variations may be restricted to suitable environments (Karavina et al., 2014).

A study carried out at the Harare Research Station evaluated eight three-way and four commercial maize hybrids with objectives of were to identify resistance to MSV (Maize Streak Virus) and TLB (Turcicum Leaf Blight) and effect on yield and diseases incidences. Result showed that he hybrid 053WH54 had resistance to both diseases. While 043WH41 and 013WH03 were recorded low yielding at low disease pressure. This showed the inherent genetic diversity of the hybrids. The hybrids ZS 225, 043WH61 and 043WH07 are recommended for production in areas with high prevalence of both diseases (Karavina et al., 2014).

Maize varieties tolerant or resistant to maize streak disease virus have long been known (Fielding,1949; Gorter,1953; Goter,1959; Rose, 1941). The first varieties discovered yielded poorly or had other undesirable qualities and were not often grown commercially. However, since Storey and Howland (1967) discovered that resistance is inherited and controlled by a major gene, with modifying genes, in maize plants, plant breeders have renewed efforts to produce streak-resistant maize varieties suitable to different countries and conditions (Bock et al., 1974; China,1928). The extent to which these are being accepted commercially is variable and is likely to remain so until they fully compete with the widely grown susceptible varieties. There is a great need for resistant varieties, which farmers will automatically plant when maize is to be grown on irrigation schemes.

Field evaluation trail conducted at southern Guinea savanna ecology of Nigeria for two years, result indicated that Acr 91 Suwan-1- SR C1 was resistant varieties comparable with the hybrid check for grain yield by 32 percent (%). The variety could therefore serve as replacement to existing cultivar and also as source of genes for future maize breeding activities in the development of superior maize varieties for the southern guinea savanna ecology (Olayo,2009).

Study conducted by Daniel (2014) [at Chilga district of Northwestern Ethiopia, during the 2013 main cropping season with objective to evaluate the performance of improved maize genotypes, all varieties showed significant differences with each other for all the trail studied. Among tested varieties P3812W variety had the highest grain yield of 4877 kg ha-1 and maximum field weight of (5.67kg.). The highest plant height of 209.67 cm was noted in variety BH 670. The local variety had maximum ear height of 106.67cm. MH138Q had maximum number of ears which is 35. Finally, the result trial concluded that maize variety P3812W was found most promising one, which is recommended for general cultivation in Chilga district in Northwestern Ethiopia.

Hybrids (H614 and H513) susceptible to MSV which are produced by the Kenya Seed Company. Therefore, Western Seed companies and Agriculture Seed Company to introduce MSV tolerant varieties such as WH403, WH505, DUMA41 and DUMA43 in Kenyan for users (Njuguna ,1996).

Conclusion

Maize (*Zea mays* L.) is a major cereal crop in many regions of the world, including in Sub-Saharan Africa. However, maize yields have remained low due to biotic, abiotic, and socioeconomic restrictions. Disease like maize streak virus is the main biotic factors limiting maize production and productivity and is becoming very important disease due to the improvement of crop protection of maize crops. Among all the disease management options, the small holder whose mainly depend maize as food crop exposed use of disease-resistant cultivars is the best approach to the management the disease.

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