Research Application Summary

Developing ecological management strategies for the aphid vectored cucumber mosaic virus on tomato in Uganda

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Abstract

This study aims to develop safe and affordable management strategies for cucumber mosaic virus (CMV) on tomato and the aphids that vector the disease as a strategy to rejuvenate and increase yields of the crop at the small scale levels. This will be done through assessment of the effect ofambient ecology and farmers' practices on host crop-vector-CMV relationships as a foundationto determine entry points for management. Subsequently, eco-friendly management strategies will be studied solely or combined for efficacy in the management of the aphid vectors and CMV on tomato. On-farm trials in a CMV hot spot region will be used to validate on-station results.

Key words: Cropping system; physical barriers; planting time, resistant germplasm

Résumé

Cette étude vise à élaborer des stratégies de gestion sûres et abordables pour le virus de la mosaïque du concombre (CMV) sur la tomate et les pucerons qui guident la maladie comme une stratégie visant à rajeunir et augmenter les rendements des cultures à des niveaux réduits. Cela se fera par l'évaluation de l'effet de l'écologie ambiante et des pratiques des agriculteurs sur les relations cultures hôtes-vecteurs- CMV comme une base pour déterminer les points d'entrée pour la gestion. Par la suite, les stratégies de gestion respectueuses de l'environnement seront étudiées seules ou combinées pour l'efficacité dans la gestion des vecteurs des pucerons et le CMV sur la tomate. Les essais à la ferme dans une région à point chaud de CMV seront utilisés pour valider les résultats à la station.

Mots clés: Système de culture, obstacles physiques, temps de plantage, matériel génétique résistant

Background

Tomato is among the most important high value horticultural crops in Uganda offering opportunities for employment creation, access to education, food security and health care to growers

of both gender (Kasenge *et al.*, 2002). However, demand for tomato produce often outstrips supply due to production challenges. The constraints include use of low quality planting material, non-availability of inputs, sub-optimum agronomic practices, and pests and disease attacks (IPM CRSP, 2001; Varela *et al*., 2003). Aphids are especially important pests because they vector several viral diseases of tomato. Recent studies have shown that viral diseases have quickly become a major threat to tomato production in Eastern Africa in general and Uganda in particular (Varela *et al*., 2003; Ssekyewa, 2006).The rate of increase in occurrence of some of the viruses is various areas of the country is worrisome, for instance, mean incidence of cucumber mosaic virus (CMV) in an earlier survey of seven districts was at 6% (Sekyewa, 2006); a recent survey (2010) shows the mean incidence at 36% (IPM CRSP, 2011).Aphid vectors spread CMV from one infected host to another through their transient feeding behaviour. Population dynamics of vectors depends on host range and presence, host preference and life history; cropping systems and environmental factors. Rate at which the virus is transmitted depends on presence of inoculum. Therefore, field environmental factors and insect pest population dynamics should be studied if one is to understand the relationship between transmitted virus and vector, and develop recommendations for sustainable management of the problem. Indeed, to increase tomato yields at smallholder levels, priority should be given to crop protection strategies based on agro-ecosystem management including measures that stabilise and reverse negative environmental trends. The goal is to keep tomato yield losses within economically acceptable margins by creating ecological conditions that can induce tolerance, prevent or suppress the development of the aphid vector and CMV disease. This approach is central to the development of integrated pest management (IPM) programs.

Literature Summary

CMV is a cucumovirus transmitted in a non-persistent manner by aphids. More than 80 species of aphids including *Myzus persicae* and *Aphis gossypi* are important vectors of CMV. The host range of CMV is estimated to extend to more than 1,200 species of plants in 100 families, resulting in ongoing, devastating epidemics worldwide in economically important crops including various cucurbits, legumes, tomato, pepper, and other crops (Zitter and Murphy, 2009). Crop losses vary from year to year since the amount of disease occurrence depends upon the number of aphids available for virus transmission in

different seasons when the crops are established as determined by geographical location. In warm seasons with less frequent rains, aphid populations increase rapidly on perennial crops that harbor CMV, in such cases, infection rates may approach 100% and the crop may have to be abandoned. On average, losses of 10-20% are common, and in some instances the crop may still be harvested, but is of poorer quality and appearance (Zitter and Murphy, 2009).Microclimatic conditions play an important role in the development and severity of plant disease, and crop diversification can either encourage or inhibit pathogen growth, depending on the particular requirements of the organism; also, utilisation of ecological tactics focusing on crop isolation, planting date and deployment of crop phenology-specific crop screens are strategies that have shown potential against another injurious vector, the whitefly (Hilje et al. 2001).

Study Description

The research will be implemented by two graduate students.Student 1 will study effect of ambient ecology (rainfall, temperature, relative humidity, wind speed and soil condition)), season and cropping system on the interaction between aphids and CMV on tomato. On-farm trials will be set up in high incidence regions in five sites. Four tomato genotypes (2 local and 2 from AVRDC) will be studied in the five sites. The trials will be established as a randomised completed block design (RCBD) with 4 replicates. Data will be collected on the abovementioned environmental factors and these will be related to CMV progression as well as aphid populations. The study will run for two consecutive seasons. Also, a survey of 15 farms in each of the study districts above will be implemented to document effect of cropping system, variety, and weed/pest/ disease management tactics on incidence of aphids and CMV on tomato. Student 2 will study the effect of using sole or combined cultural practices in the management of aphid vectors and CMV on tomato. On-station, a split plot trial with two factors, i.e., tomato genotype in main plots and differential insect proof row-covers implemented at different times in the crop cycle in subplots will be studied. Four genotypes (2 local and 2 obtained from AVRDC) will be studied. For each genotype; four treatment will be imposed i) insect proof row covers (portable custom sized tunnels covered with fine mesh) implemented from transplanting to 14DAT; 2) insect proof row covers implemented from transplanting to 28 DAT; insect proof row covers implemented from transplanting to 36 DAT; and 4) no row cover (control). The subplots will be replicated three times. Data will be collected of CMV incidence and severity as well as on yield

parameters. In another split plot trial, physical perimeter barrier will be the factor in the main plots whereas date of planting will be the factor in the subplots. In the main plots presence of living physical barrier vs. no barrier will be investigated whereas in the subplots three dates of planting will be investigated – i) at onset of rains; 3 weeks after onset of rains, and 5 weeks after onset of rains. In the plots with the living barrier, maize will be planted earlier and will be at the 2m height around the perimeter when the tomatoes are introduced. Three replications of the subplots will be planted. Data will be collected as in the previous trial. Both trials will run for two consecutive seasons. Concurrently in the second season, the treatments from season one of the two studies that would have given the best results will be studied in a trial assessing combined vs. sole measures in an on-farm trial in the district with the highest CMV incidence as per the results of student I. Cost: benefit ratios associated with each management strategy will be calculated. Field days will be hosted in the course of the on-farm validation trial as a dissemination strategy to initiate farmer-to-farmer technology transfer.

Research Application

From the study, it is expected that: avenues to reduce aphid occurrence and curtail spread of CMV on tomato in Uganda will be established. Weak links in the vector-virus-crop host relationship that can be exploited in developing sustainable management packages for CMV and other aphid-vectored diseases on tomato, and other similarly affected crops in the country will be determined, and safe, cost-effective and easy to apply strategies for exploiting the weak links developed.

Recommendations

The study will use the results to design an IPM package for sustainably managing the disease in Uganda.

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