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Proposed assessment scale for dieback disease severity on passion fruit

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1 SUMMARY

Dieback disease is currently the most economically important disease in passion fruit production in Kenya. The disease gained epidemic status within 4 years of its first recording in 2004. It is estimated that the disease accounts for about 70% of total pre-harvest passion fruit loss in the country. Dieback exhibits a high level of complexity in its symptomatology, pathogenicity and epidemiology. The disease is fairly new in Kenya and has not been reported in other parts of the world where passion fruit is cultivated. These factors coupled with the lack of preparedness to mount an effective response have made it difficult to successfully manage dieback. To develop effective dieback management measures, it is necessary to establish standard tools and protocols for evaluating disease incidence and severity. This paper presents a proposed dieback disease severity assessment scale (scoring chart). The scale is based on observations over a period of over 8 months in Eastern and Central Kenya where passion fruit is an important crop and dieback disease is prevalent. Photographs of diseased plants showing disease evolution/progression were taken at regular intervals. Additional data were collected from controlled experiments to validate field observations. The proposed assessment scale comprises of 5 assessment levels assigned based on observed symptoms. Recommended disease management options are also discussed for each infection level. Photos to aid in symptom description are included.

2 INTRODUCTION

Passion fruit is indigenous to Brazil and Argentina and was introduced to Kenya in the 1920's by the European settlers (Acland, 1971; Morton, 1987). Two passion fruit varieties are predominantly grown in Kenya. They include purple passion (*Passiflora edulis* Sims) and the yellow passion (*Passiflora edulis* var *flavicarpa*) (De Villers and Fraser, 2000). Although the purple variety is most preferred due to its high juice and sugar contents which are important for juice extraction (Fushimi et al, 2001), it is highly susceptible to fungal diseases such as brown spot, Fusarium wilt and canker, Phytophthora canker and blights and dieback, among others. Diseases and pests are the major constraints to production. Dieback contributes 70% of all fruit lost at farm gate due to effects of diseases (Wangungu et al, 2010). The disease is fairly new to passion fruit production in Kenya and it gained its epidemic status over a short time span which is a distinguishing character of most epidemic diseases. For example, in a survey carried out in 2004, the leading passion fruit diseases were brown spot *Fusarium* wilt; *Phytophthora* root rot and Passion fruit woodiness virus disease (Mbaka et al, 2006). However, by 2010, the leading disease constraint was dieback. Dieback is difficult and

complex to manage; in there is no documented occurrence of the disease elsewhere in the world. The disease has a wide complexity of the symptom exhibited (symptomatology), number and diversity of causal organisms isolated from diseased materials (etiology) and the diversity of possible dissemination pathways (epidemiology).

In Latin America (Venezuela) where the passion fruit crop originated, collar rot disease has been observed, its symptomatology (wounds on the main vine close to the graft union) and etiology (*Phytophthora* fungal spp) shows significant relationship to dieback (Gonzales et al, 2000). A similar case was also observed during a study in Uganda (Ssekyewa et al, 1999). In other passion fruit producing countries, the disease documented as dieback differs in symptomatology when compared to the disease being experienced in Kenya. In Brazil for example, dieback is recorded as an unimportant disease of passion fruit caused by lack of nutrients and insect damage to the vine tips. In Kenya the disease has been linked to effects of brown spot wounds as a secondary symptom (Infonet-biovision, 2010).

Where information regarding a crop disease is unavailable, as in the case of dieback, it is not possible to develop effective disease management measures and the disease can cause significant havoc. Identification of effective dieback disease management measures has been slow in Kenya, partly due to the complex nature of the disease, but also due to inefficiencies in extension, research, policy and other levels. In this paper we aim to contribute to efforts to identify effective measures by developing a disease assessment/scoring system, which can be used by researchers, extension agents and producers to design and implement interventions. The scoring chart aims at assisting all stakeholders involved in fruit production to design informed disease forecasting and monitoring schedules that will be important in guiding the management options applied. This in turn will lay the foundations for development of effective dieback disease management programs, key in reviving the passion fruit industry in KenyaThe scoring chart takes into account the various symptoms exhibited by the dieback disease and assesses severity at plant level.

3 MATERIALS AND METHODS

Field visits to observe infected plants were carried out and data recorded. Diseased passion fruit samples collected from the field were subjected to pathogen isolation in the laboratory. Controlled experiments to reproduce and verify the symptoms observed in the field were carried out at Kenyatta University. Pure cultures of isolated pathogens were used to infect healthy, ungrafted seedlings of the purple passion fruit variety. The seedlings were 5 months old and were grown in pots under greenhouse conditions. The pathogen cultures were also used to inoculate healthy vines of mature plants.

4 RESULTS AND DISCUSSIONS

Based on the symptoms observed, the following disease scoring chart with 5 incremental severity levels is proposed.

4.1 Level 1 (0% severity): At level 1 (illustrated in figure 1) there are no symptoms observed on plant hence plant is healthy. Protective disease measures may be needed depending on the level of threat of infection.

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Whole crop healthy Flowers healthy Fruits healthy, spotless

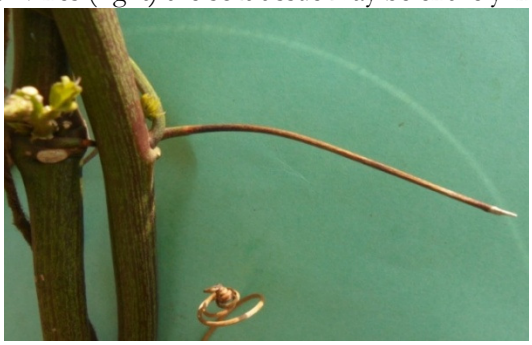
Figure 1: Appearance of passion fruit tissues at level 1 (healthy) of dieback assessment / scoring scale.

4.2 LEVEL 2 (1 – 15% severity): This is the early infection level and the disease is at the initial stages of establishment. It is the best stage to apply curative measures to stop any further progress. A suitable curative fungicide, e.g. Ridomil® can be applied; coupled with proper sanitation measures to eliminate or reduce sources of inoculum.

Note: For this and subsequent levels the symptoms may be expressed on different plant organs. Observations should therefore be made on different organs as described in each figure. Occurrence of symptoms on multiple plant parts/ organs should not be aggregated to imply a higher degree of severity. Observations are;

- Spots just starting to appear on the vine; no more than 1 spot per vine.
- Tendrils withering from the tips on at least 1 vine (either main vine or on the auxiliary vines).
- One flower showing infection with initiation of dieback
- One branch showing dieback initiation.
- Less than 5 spots on fruits, each spot less than 0.25 cm diameter.


Spots appearing on vines; on older vines (left) the infection usually superficial and not deeper than bark; on younger vines (right) the soft tissue may be entirely infected with water soaked appearance.




Tendril withering from the tip Spots appearing on fruits (<0.25cm)

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Initial leaf blighting and flower infection

Figure 2: Appearing of passion fruit tissues at level 2 of dieback severity.

4.3 LEVEL 3 (16 – 40% severity). At level 3, the disease status is moderately high and integrated disease control measures are required to stop disease spread to the uninfected areas outside of the field, within the field and at plant level. This is the crucial stage to determine the rate of disease spread and effectiveness of control measures.

Observations

- Tendrils dead and infection entering into the adjoined vines.
- At least 1 auxillary vine completely blighted and disease entering main vine.
- Spots on more than 3 places on the main vine, with spots coalesced to form a lesion of at least 1cm length.
- More than 5 spots per fruit, some spots expanded to 0.5 cm diameter; but fruits still attached to the vines.
- Several flowers completely withered.

Spots at multiple sites on the vines.

Tendrils die, infection enters main vine

Spots on vines expand transverse (left) and may form pits on the bark (right).

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At least 1 auxillary vine completely blighted and disease entering main vine; More than 5 spots on fruits, some spots expanded to 0.5 cm diameter or more; but fruits still attached to the vines.

Figure 3: Scale 3 of passion dieback severity level (16 – 40% severity).

At level 3, the disease is moderately severe. Disease management measures at this level aim at slowing down disease progress since dieback has no known curative measures. Options include use of fungicides, proper plant nutrition to boost the plant's natural disease resistance, e.g. Mavuno® fertilizers for fruits and trees; and cultural practices such as rouging diseased plants.

4.4 Level 4 (41-75% severity). At level 4 infection is highly severe and not much can be done to stop disease spread at plant level. Stringent measures involving uprooting of infected plants and their consequent destruction are recommended. Measures include cutting down the crop to 10 cm above the graft union where new tissues can regenerate and then the new crop can be managed properly or carry out intense pruning to remove all infected vines.

Observations

- One main vine dead at least 2/3 of its entire length or to the graft union level; most often infection starting on the adjoining main vine.
- Leaves on the auxillary and main vines blighted and falling
- Fruits severely withered but may still be attached.
- Infection spots on vines turn to severe wounds with cavities and dead bark.
- No new flowers forming.

Expanding lesions on infected vines show distinct phases of diseased tissue (left); wounds with dead bark and (middle) and vine tips dying rapidly (right).

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Fruits on infected plants wither and start dropping off prematurely.
Figure 4: Scale 4 of passion dieback severity level (41 - 75% severity).

4.5 LEVEL 5 (≥76 - 100% severity). At level 5, the plant is completely dead or rapidly dying. Infected plant acts as a reservoir for disease dissemination and should therefore be uprooted and destroyed to minimize spread.

Observations

- Infection on both main vines (where 2 are retained)
- Plant >75% defoliated
- >50% of fruits shriveled and dropping prematurely.
- Entire plant drying up

Fruits fallen prematurely

Leaves withered and leaves falling

Vines dried up completely and leaves fallen completely.
Figure 5: Scale 5 of passion dieback severity level (70 - 100% severity).

5 CONCLUSION AND RECOMMENDATIONS

To realize the full benefits of the guidelines offered in this proposed disease severity assessment scale, frequent disease monitoring is recommended. Protective disease management options are advisable because:

- Once a plant or field is infected, it is hard to get rid of the disease.
- Kenya is a large exporter of fruits and other horticultural products to the international markets. Recent measures require that export products observe Maximum Residue Levels (MRLs) set in internationally. Since fungicides currently in use in dieback management programs seem to be active at higher than the recommended rates and at shorter application cycles, there is a risk of exceeding the set MRLs which could lead to rejection of produce in the international markets and endangering local consumers.

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