African Phytosanitary Journal
ISSN 2617-1856 (Paper) DOI: 10.52855/QUYK4062
Volume 3, Issue 1, 2022

Distribution of passion fruit (*Passiflora spp.*) pests in Kenya

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Abstract

Passion fruit (*Passiflora edulis*) is an important fruit crop with great commercial potential since the demand for both fresh fruit and processed juice for both local and export is on the increase. Like in other countries, passion fruit productivity in Kenya is low due to both biotic and abiotic constraints. Pest and diseases contribute largely to non-availability of clean planting material. Woodiness disease caused by viral pathogens is one of the most devastating diseases of passion fruit in the world. The disease results from synergistic interactions of potyviruses that are vectored by aphids. However, the distribution of the economically important pests for the crop is not well documented. Surveillance was carried out to establish the distribution of the pests in the major growing areas in Kenya between March and May, 2019. A total of 69 farms were sampled and 142 samples were collected. Most farmers (95%) prepared their own seeds for sowing from previous crops which they also shared amongst the neighbors. Passion fruit woodiness (PWD) was the major disease observed in most farms in Uasin Gishu, Marakwet, Nyamira and Kisii Counties. Majority of the farmers (75%) rated PWD as the major constraint to passion fruit production followed by Fusarium wilt. However, in Nyeri, Embu and Meru counties, farmers rated fusarium wilt as the major constraint followed by PWD. There was decrease in passion fruit production in all areas surveyed whereas in some Counties like Baringo, Nakuru and Migori had totally abandoned the production of this crop, mainly due to the devastation of PWD. Upto 46% of the samples tested positive for potyviruses. Elgeyo Markwet recorded the highest incidence potyviruses at 69% followed by UasinGishu at 68%. Bungoma County had the least potyviruses incidence at 17%. *Fusarium sp* and *Colletotrichum spp* were detected in 4 samples. Passion fruit farming has reduced due to biotic constraints mainly PWD and *Fusarium sp*. There is need for farmers to access and adopt use of certified seedlings in order increase productivity.

Key words: Passion fruit (*Passiflora spp*), pests, *surveillance, Distribution, Kenya*

Introduction

Passion fruit (*Passiflora* spp.) is the third most important fruit crop in Kenya after mango and avocado in terms of foreign exchange earnings (Kahinga *et al*., 2006). Passion fruit is mainly grown by small-scale farmers for subsistence and commercial reasons. Both yellow and purple varieties are grown in Kenya. The purple passion variety is adapted to areas within 1200 to 2000 m above sea level. The major passion fruit growing areas are in Central (Thika, Muranga, Nyeri and Kirinyaga), Eastern (Embu and Meru Central), Rift Valley (Nakuru, Baringo and Kitale), Western (Bungoma and Kakamega), Nyanza (Kisii and Nyamira) and Coast (Taita-Taveta, Kwale and Kilifi). Mostly passion fruit is produced by small-scale farmers on 0.25 to 2 acres of land (Wasilwa *et al*., 2004). In 2014, the area under passion fruit production in Kenya was approximately 4,288 ha. The passion fruit industry in Kenya is faced with production and marketing constraints. Despite the economic importance of the crop, the average yield in Kenya is still relatively low at 8 ton/ha compared to about 18.9 ton/ha in South Africa, and 24 ton/ha in Australia (Morton, 1987).

Passion-fruit farming could be an extremely remunerative enterprise in Kenya with high and regular income. It is one of the biggest fruit exported by Kenya. The local market demand is also quite high. The crop is pliable to a good agro-ecological zone from low lands to the highlands. The demand for the fruit on every export and domestic market keeps on growing. Large quantities of passion fruits are eaten raw locally and at constant time, they're conjointly exported. East Africa could be a massive provider of recent purple passion fruits to the export market followed by Brazil, Colombia, Zambia and Rhodesia; of that the U.K is that the largest customer.

Low productivity in Kenya is attributable to diseases like brown spot (*Alternaria passiflorae*), Fusarium wilt (*Fusarium oxysporum* sp. passiflorae) (Gardener, 1989) and woodiness virus caused by a complex of potyviruses including the cowpea aphid-borne mosaic virus (CABMV). The diseases have reduced the productive life of passion fruit from 5 to 2 years (Fushimi, *et al.,* 2001). Yield losses of 40 to 100% due to diseases have been reported (Wasilwa *et al.,* 2004; Wangungu *et al.,* 2010). In the past insect pests were not considered to cause significant losses on passion fruit. Recent observations indicate that the crop is subject to attack by a wide range of insect pests including aphids and mealybugs. This study was carried out to assess the distribution of passion fruit pests in major production areas in Kenya.

Materials and methods

Survey area

Field survey was conducted in passion fruit growing regions found in Western Counties (Kakamega, Bungoma, Uasin Gishu, Busia, Vihiga, Homabay, Siaya, Migori, Kisii, Nyamira), Central Riftvalley

(Nakuru, Kericho, Elgeyo Marakwet, Baringo, Bomet, Narok), Central (Nyandarua, Kirinyaga, Nyeri, Murang'a, Meru, Kiambu) and the Coast (Kwale, TaitaTaveta, Lamu, Kilifi, Tana River) regions in Kenya between March and May, 2019.

Sample size and Sampling Procedure

A stratified randomized sampling approach was adopted. Counties represented strata while farms were selected randomly based on availability of the crop at the time of survey. Passion fruit fields/nurseries were sampled along motorable roads at a predetermined distance intervals of 2-5 km whenever the crop was grown. Orchards were examined diagonally at random and seedlings showing disease symptoms counted along 2 diagonals. Disease incidence was determined by considering the ratio of the number of plants with symptoms to the number of plants examined expressed as a percentage (James, 1974). Incidence and severity of observed pests was recorded. Severity was determined using the scale 1 to 5 where; 1=no symptom 2= very mild, 3= mild, 4= severe and 5= very severely infected. Farmers were asked to provide information on the type of variety planted, source and major challenges faced. All data was captured in an Open Data Kit (ODK) software on smart phones following a preset questionnaire. Disease prevalence per region was estimated as the proportion of nurseries/farms having disease symptoms expressed as a percentage of the total number of nurseries/farms visited in the region. The estimated sample size was 384 farms at 95% confidence interval.

Sample collection

Virus samples

Samples were obtained from plants expressing virus-like symptoms. Plants manifesting different levels of wrinkling, mosaic, chlorosis, vein clearing, ring spots, distorted leaves and shortened stems were collected. In cases of nurseries where seedlings were asymptomatic, 10% of every 200 seedling count were sampled. Trifoliate leaflets were collected per plant consisting of top, middle and the bottom leaf. The samples were kept in a labelled Zip Lock sealable polythene bags (size 12 x 8cm), containing approximately 10 grams of silica gel (Sigma S-5631). The Zip Lock bags were shaken to distribute the silica gel between the layers of leaves for sufficient drying.

Bacterial and fungal samples

Symptomatic stems and leaves with characteristic bacterial and fungal infection were collected and carried in properly labelled khaki bags. In cases of nurseries where seedlings were asymptomatic, 10% of every 200 seedling count was sampled.

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Laboratory analysis

Bacterial and Fungal analysis

Bacterial samples were cultured aseptically in suitable media followed by biochemical tests. Fungal samples were also cultured on Potato dextrose agar and microscopy done. Positive samples were confirmed through molecular analysis.

Viral analysis

Seventy seven (77) samples were tested for potyvirus using Double sandwich enzyme-linked immunosorbent assay (DAS-ELISA) (Aritua *et al.,* 1998) using kits obtained from Agdia according to manufacturer's instruction. 1g of leaf tissue was grounded in 1ml of extraction buffer using a pestle and mortar. Each test well was coated with 100µl of antigen (diluted sample extraction) including the positive control. Each sample was replicated twice. The plate was incubated in a humid box for 1 hour at room temperature. After completion of sample incubation, the plate was emptied, filled with 1X PBST then washed 8 times till the wells were free from plant tissue. Thereafter, 100ul of antibody was dispensed in each well. The plate was placed in humid box before incubation at the temperature of 2-8°C in a refrigerator overnight. The microtiter plate was washed 8 times with 1X PBST. 100µl of enzyme conjugate was dispensed in each well then incubated in humid box for 1 hour at room temperature. The microtiter plate was washed 8 times with 1X PBST then 100ul of PNP substrate added in each test well and incubated for 60 minutes in a dark room at room temperature. The plates were evaluated by a spectrophotometer (405 nm) reader. ELISA absorbance data was recorded and an average of each sample made. Samples with absorbance values twice those of the healthy control were considered positive.

Results

Field observations

Farm sizes under passion fruit production ranged between 0.1 to 2 acres. The main variety under production was the purple passion in all the regions. Most farmers (95%) prepared their own seeds for sowing from previous crop which they shared with their neighbors. All nurseries surveyed also used recycled seeds. Passion fruit woodiness (PWD) was the major disease observed in most farms. Other diseases observed were Fusarium wilt, Phytopthora rot and Brown spot disease. Some of the disease symptoms observed on passion fruit were woody-like cracking fruits, chlorosis and mosaic on young leaves, brown spots on fruit, stem necrosis, entire plant wilt, chlorotic blotches on mature leaves, browning on vascular tissues at base of stem, dry stem with darkened pith (Fig. 1).

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Figure 1: Some of the disease symptoms observed on passion fruit: **a** – Woody-like cracking fruits, **b** – chlorosis and mosaic on young leaves, **c** – brown spots on fruit, **d** – stem necrosis, **e** – entire plant wilt, **f** – chlorotic blotches on mature leaves, **g** – browning on vascular tissues at base of stem, **h** – dry stem with darkened pith.

There was decrease in passion fruit production in all areas surveyed whereas in some Counties like Baringo, Nakuru and Migori had totally abandoned the production of this crop, mainly due to the devastation of passion fruit woodiness disease. In Meru, Embu and Nyeri counties the abandonment was as a result of *Fusarium sp* and *Alternaria* sp infestations.

Virology analysis

Samples subjected to virus tests, 46% tested positive for potyviruses. Elgeyo Markwet had the highest incidence at 69% followed by Uasin Gishu at 68%. Bungoma County had the least disease incidence of 17% (Table 1).

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Table 1: Distribution of positive Potyviruses samples from all regions sampled

Region	Number of samples analysed	No. of positive results	% disease incidence
Kisii	7	2	29
Nyamira	12	4	33
Kakamega	5	2	40
Kitale	14	5	36
Bungoma	6	1	17
UasinGishu	19	13	68
Elgeyo Markwet	13	9	69
Nyeri	7	3	43
Embu	10	4	40
Total	**93**	**43**	**46**

Mycological analysis

The samples were cultured the emerging fungi identified based on morphological features. Four samples tested positive for *Fusarium sp* and *Colletotrichum spp* (Table 2).

Table 2: Morphological analysis of fungal pathogens

Sample number	Sample type	Results
03	Purple Passion	*Fusarium spp* +ve
22	Yellow passion	*Fusarium spp* -ve
28	Local passion	*Fusarium spp* -ve
05	Passion	*Fusarium spp* -ve
25	Sweet passion	*Colletotrichum spp*+ve
29	Passion	*Alternaria spp* -ve
21	Yellow passion	*Fusarium spp* -ve
15	Passion	*Fusarium spp* +ve
19	Grafted passion	*Colletotrichum spp +ve*

Discussion

About 75% of the farmers rated PWD as a major constraint to passion fruit production. This was confirmed further by laboratory tests with 46% of the samples tested being positive for the potyviruses. The farmers had knowledge of PWD disease and have nick-named it "*Kangumu*", which is a Swahili word meaning "Hard". However, there was no information on how its spread and management options available. This demonstrates that there is little knowledge about the PWD among the passion fruit farmers. This therefore contributes to further spread of the disease mainly through the use of diseased seedlings. During the survey, the farmers were mostly establishing their seedlings using seeds obtained from their farms. These are the same farms where PWD was very prevalent. PWV is probably mostly transmitted by contaminated tools and through vegetative propagation materials (CABI, 2021). Considering that the PWD viruses can occur in latent form, farmers will unknowingly transmit the disease during pruning and other farm activities. This could be attributed to the extensive spread of the PWD more than other diseases such as Fusarium wilt which was initially the most rampant in passion fruit farms.

Fusarium disease was the second major challenge, however there was less knowledge of this disease amongst the sampled farmers, most attributed it to drought. The disease was more prevalent in Nyeri, Embu and Meru counties and farmers rated Fusarium disease as the major limitation to production of the crop in these regions. Many stakeholders in the passion fruit value chain acknowledges that the major challenge in passion fruit production is lack of clean planting materials free from *Fusarium wilt* which is rampant in the country (Market Access Upgrade Programme, 2020). The lack of knowledge on this disease could be the main contributor to its widespread as the farmers are not able to practice effective management of the disease. Understanding of the disease cycle, including climatic and other environmental factors that influence the cycle, and cultural requirements of the host plant, are essential to effective management of any disease (Maloy, 2005).

Other diseases observed in all regions surveyed were, Phytopthora rot and Brown spot disease. Insect pests detected were the mites but in very few farms in UasinGishu while in Nyeri/Embu we had mealybugs. In the past insect pests were not considered to cause significant losses on passion fruit. Recent observations indicate that the crop is subject to attack by a wide range of insect pests including aphids and mealybugs. This imply that the threat of insect pests on passion fruit could be on the rise especially with the current incursions of new pests in the country of wider host range. Aphids were not

observed in all the regions sampled and this could be attributed to high amount of rains in most places that were surveyed. Rainfall has previously been shown to be a factor regulating the population of aphids as it can dislodge the pest from their host plants (Kaakeh and Dutcher 1993).

In 2017-2018, the area under passion fruit cultivation in Kenya increased from 2,157 Ha to 2,296 Ha (HCD, 2018). However, production and value dropped by 12,499 tons and Kshs 109 million due to diseases such as fusarium wilt, dieback and PWD. The decline in volumes led to decrease in value. This is what was observed during the surveillance as in some counties such as Baringo and Nakuru, farmers had completely abandoned passion fruit production.

Conclusion

Passion fruit farming has reduced due to biotic constraints mainly passion fruit woodiness and Fusarium sp. There is need for farmers to access and adopt use of certified seedlings in order increase productivity. KEPHIS in collaboration with county government to be encouraged to sensitive farmers on the economic importance of this crop as this would lead to increased hacterage especially in counties like Kisii, Nyamira, Marakwet and UasinGishu, where farmers had interest in growing the crop but were limited by diseases.

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