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FARMERS' KNOWLEDGE OF PASSION FRUIT VIRUS DISEASES AND THEIR MANAGEMENT IN CENTRAL UGANDA

Atukunda Robinah[a], Sseruwagi Peter[c], Karungi Jeninah[a], Kyamanywa Samuel[a], Erbaugh Mark [b] and Ochwo-Ssemakula Mildred [a,*]

[a]Atukunda Robinah, College of Agricultural and Environmental Sciences, School of Agricultural Sciences, Makerere University, P. O. Box 7062, Kampala, Uganda, barobyn2000@gmail.com

[a]Dr. Ochwo-Ssemakula Mildred, College of Agricultural and Environmental Sciences, School of Agricultural Sciences, Makerere University, P. O. Box 7062, Kampala, Uganda, mknossemakula@caes.mak.ac.ug

[a]Assoc. Prof. Karungi Jeninah, College of Agricultural and Environmental Sciences, School of Agricultural Sciences, Makerere University, P. O. Box 7062, Kampala, Uganda, jkarungi@caes.mak.ac.ug

[a]Prof. Kyamanywa Samuel, College of Agricultural and Environmental Sciences, School of Agricultural Sciences, Makerere University, P. O. Box 7062, Kampala, Uganda, skyamanywa@caes.mak.ac.ug

[b]Dr. Erbaugh J. Mark , International Programs in Agriculture, Ohio State University, OARDC, Wooster, OH, 44601-4096, USA, erbaugh.1@osu.edu

[c]Dr. Sseruwagi Peter, Mikocheni Agricultural Research Institute, P. O. Box 6226, Dar es Salaam, Tanzania, psseruwagi@yahoo.co.uk

* Correspondence: mknossemakula@caes.mak.ac.ug

Abstract

Passion fruit production has decreased over years in Uganda. Biotic and management related factors have been implicated as the cause, with viruses taking lead. In order to understand the production environment of Passion fruit, this study was initiated. Specifically, the focus was to investigate the relationship between farmers' knowledge of virus diseases and their management. To achieve this, a survey was conducted in Buikwe and Mubende districts, central Uganda in 2011, also considered virus disease hot spots. Sixty farmers were purposively selected and interviewed using structured pretested questionnaire. Data were analysed using Package for Social Sciences (SPSS) data analysis package. Results indicated that diseases followed by pests were the main production constraints. Majority (80%) of the farmers acknowledged passion fruit virus diseases as a major production limitation. Seventy three (73%) percent recognized the diseases by symptom description. Only a minority (5%) claimed to be aware of the cause of passion fruit virus diseases, which they attributed to use of virus-infected planting materials. Thirty two (32%) percent considered the cause to be direct insect feeding damage. None of the farmers pinpointed the causative pathogen to be virus(es). Farmers (95%) lacked knowledge of passion fruit virus diseases transmission. Pesticide application was the key disease management strategy. The management of viruses was weakly associated (X^2 = 12.05, P < 0.001) with farmers' level of education but not their production experience nor understanding of virus causes. Farmers used their own experience to deploy management strategies. The findings call for farmers' sensitization on the cause, means of transmission and spread of virus diseases. This study provides baseline information for development of a durable integrated pest disease management (IPDM) strategy for passion fruit virus diseases in Uganda.

Keywords: Field survey, disease spread, IPM, production environment, epidemiology

Introduction

Commercial passion fruit (*Passiflora edulis* Sims.) production in Uganda has declined over the past two decades due to biotic and management-related factors (Ssonko *et al*., 2005). Diseases alone reduce the productive life of the crop from 5 to 2 years (Fushimi *et al*., 2001), with viruses in particular causing yield losses of 40 to 100% (Wasilwa *et al*., 2004). Passion fruit virus diseases in Uganda have largely been attributed to the Ugandan Passiflora potyvirus (Ochwo-Ssemakula *et al*., 2012), a novel potyvirus species most closely related to the *Watermelon mosaic potyvirus* described by Desbiez & Lecoq (2004). Elsewhere, virus diseases in passion fruit are caused by viruses that include; *Passion fruit woodiness virus* (PWV), *Cowpea aphid borne mosaic virus* (CABMV), *Cucumber mosaic virus* (CMV) and *East Asian Passiflora virus* (EAPV) as cited by Fisher & Rezende (2008). These cause various symptoms on the plants including fruit hardiness or woodiness, leaf wrinkling, rugosity, ringspots, chlorosis and mosaic among others.

Potyviruses are naturally transmitted non-persistently by several aphid species including green peach aphid (*Myzus persicae*), cotton aphid (*Aphis gossypii*), green citrus aphid (*A. spiraecola*) and black citrus aphid (*Toxoptera citricidus*). Grafting and mechanical inoculation transmission is also possible (Fischer & Rezende, 2008). Both the potyviruses and aphid vectors have a wide host range on plant species in families Fabaceae, Solanaceae, Amaranthaceae, Chenopodiaceae, Leguminosae, and Passifloraceae among others that can be found growing in farmers' fields (Ochwo-Ssemakula *et al.*, 2012).

Aphid-borne non-persistent viruses (ABNPVs) can be managed by targeting the source of inoculum (Irwin, 2000), which include: planting material, volunteer crops, and alternate hosts of both the vector and viruses. Management of passion fruit virus diseases in Uganda presents challenges, considering the limited knowledge on the production environment in farmers' fields. Farmers' traditional knowledge, often generated with years of experience, can play a major role towards attaining adequate interventions and sustained agricultural development. Farmers' knowledge and perception of passion fruit virus diseases and their causes are not documented. This study, therefore, aimed to investigate the relationship between farmers' knowledge of virus diseases and their management. More specifically, the study aimed to collect baseline information on: (i) passion fruit production practices, environment and constraints, (ii) major diseases affecting passion fruit and their management strategies, (iii) farmers' knowledge and perception of passion fruit virus diseases, and (iv) farmers' perception on mulching and weeding as alternative management strategies. The knowledge generated by the study will inform the development of a durable integrated pest disease management (IPDM) package for passion fruit virus diseases and associated insect vectors.

Materials and methods

A household survey was conducted in Buikwe (0^0 35'N, 33^0 02'E) and Mubende (0^0 36'N, 31^0 24'E), two major passion fruit producing districts and virus disease hotspots in Central Uganda (Ochwo-Ssemakula *et al*., 2012), in October 2011. Purposive sampling (Pallinkas *et al*., 2015) was used to select passion fruit farmers with a minimum of five passion fruit plants. Passion fruit farmers in Uganda are not organised into groups. Production is mostly on a subsistent small scale basis, with some large scale producers. Orchard size, on average, is approximately twenty to one hundred plants for the small scale farmers, whereas for the large scale farmers, it can go up to a thousand plus plants. Statistics on the number of passion

fruit farmers per region are scarce. A structured questionnaire was developed and pre-tested on five farmers prior to conducting the study. Enumerators with knowledge of one of the local languages (Luganda) in Uganda administered questionnaires using face-to-face interviews. A total of 60 household heads were interviewed, with 31 and 29 from Buikwe and Mubende districts, respectively.

Key information that was captured included: (i) demographic data for respondent age, gender, highest education level attained, family size, occupation and farm size, (ii) passion fruit production environment including variety grown, production system, type and source of planting material, agronomic practices and production constraints, (iii) major diseases affecting passion fruit and their management strategies, (iv) farmers' knowledge of passion fruit virus diseases, causes and interventions, (v) farmers' perception of mulching and weeding as possible management practices. In addition to the interviews, field observations were made in the company of the farmers to assess disease presence, symptom severity and other observations.

Data collected was tabulated and statistically analyzed using the Statistical Package for Social Sciences (SPSS) Version 16. Descriptive statistics and frequencies were used to characterize farmers' knowledge of passion fruit virus diseases and their management. Chi square and Independent sample t tests were used to determine the relationship between the variables.

Results and Discussion

Demographic characteristics of passion fruit farmers

The majority of household heads interviewed were males (90%) and the average age and family size of the farmers was 38 years and 7 members, respectively. Seventy six percent (66%) of the respondents had attained some formal education at primary (43%), secondary (25%) and tertiary (8%) levels. All the respondents practiced farming as their main occupation. The findings on male dominance of household headship and education level are in agreement with studies in Central Uganda (Mugisa *et al*., 2017). Passion fruit, being a priority crop with the potential to alleviate poverty among smallholder farmers (Ssonko *et al*., 2005), it was not surprising that relatively younger farmers were growing the crop. Lately, even professionals who have attained tertiary education opt for passion fruit farming because it is more rewarding than formal employment (Koigi, 2017).

Passion fruit production practices and environment

Farm holdings were generally small, with most farmers owning less than 5 acres of land, of which at least 1 acre was dedicated to passion fruit production (Table 1). Passion fruit production is usually grown as a supplemental source of income, with small acreages of less than an acre bringing in good incomes (Koigi, 2017).

Table 1: Demographic characteristics of passion fruit farmers in central Uganda, 2011

	Buikwe		Mubende		Total responses
	Females	Males	Females	Males	
Variables	n (%)		n (%)		n (%)
Gender	4(7)	27(45)	2(3)	27(45)	60(100)
Education					
No formal education	2(3)	6(10)	1(2)	5(8)	14(23)
Primary	1(2)	15(25)	-	10(16)	26(43)
Secondary	1(2)	5(8)	1(2)	8(13)	15(25)
Post-secondary	-	1(2)	-	4(7)	5(8)
Occupation					
Farmer	3(5)	24(40)	2(3)	23(38)	52(86)
Business	1(2)	3(5)	-	3(5)	7(12)
Teacher	-	-	-	1(2)	1(2)
Total land owned by farmers (acres)					
<5					38(63)
5.1-10					9(15)
>10.1					13(22)
Passion fruit farm size (acres)					
<1					43(72)
1.1-2					9(15)
>2					8(13)
Years of experience with passion fruit					
<5					41(68)
5-10					9(15)
>10					10(17)

n (%) is frequency and percentage per respondents

More than half (60%) of the farmers had produced passion fruit for less than 5 years. Only 17% had over 10 years' production experience, which is not surprising since the crop had been abandoned by farmers due to the virus disease surge of the 90's to early 2000's (Ssonko *et al*., 2005). Passion fruit was mainly grown for sale (95%) by men (60%) and the family (35%). Kawanda hybrid was the preferred (95%) variety probably because it is high yielding, has an acceptable flavour and produced much juice. It was produced from grafted seedlings by 63% of the farmers. The rest (37%) of the farmers produced passion fruit from seed. The biggest percentage (85%) of the farmers sourced their planting material from their own gardens. Only 15%, bought from private nurseries. Farmers produced their own planting material since they were knowledgeable on grafting and had a ready scion source from their mother gardens.

At least 55% of the respondents employed inputs in passion fruit production. Of these, 24%, 17% and 9% applied manure, pesticides and fertilizers respectively. A very small proportion of the farmers applied fungicides

(3%) and herbicides (2%). Almost all the interviewed farmers (98%) produced passion fruit as an intercrop with coffee (70%), bananas (63%), beans (58%), maize (45%) and cassava (40%) in descending order of importance. Fruit trees such as avocado, jackfruit and mangoes served as support systems for the passion fruit vines. It was mainly produced intercropped with other crops perhaps due to limited land and the nature of the crop that allows for this production system.

The majority (63%) of farmers' fields were weedy, with the farmers attributed this to limited labour resources (41%) and heavy rains (13%) during the particular season the study was conducted. However, at least 9% of the farmers did not give an explanation as to why farms were weedy. The weeds found growing within the vicinity of passion fruit plants were from diverse plant families including Leguminosae, Solanaceae, Curcurbitaceae, Amaranthaceae, Chenopodiaceae and Graminae among others. Particular plants and/or weed species such as *Bidens pilosa*, *Sonchus oleraceus* and *Capsicum annuum* were found with colonies of different aphid species. Presence of alternate hosts facilitates disease spread by provision of a ready inoculum source given the non-persistent transmission nature of the potyviruses (Hobbs *et al*., 2000). Additionally, the aphid species found on these secondary hosts including *Myzus persicae*, *Aphis gossypii*, *A. spiraecola*, and *Toxoptera citricidus* among others are known vectors of passion fruit potyviruses (Fischer and Rezende, 2008). In other words, presence of weeds colonised by aphids in the farmers' fields confounds virus disease management in passion fruit production in the absence of resistant or tolerant varieties since control of the aphid vectors using chemical means in not viable (Rodrigo *et al.*, 2013).

Farmers undertook basic agronomic practices required in passion fruit production including: trellising (100%), staking (100%), transplanting (87%), gap filling (67%), weeding (63%), pruning (55%), manure addition (43%), slashing (38%), spraying (37%), fertilizer application (15%), irrigating (12%) and mulching (6%). Generally, all activities were undertaken solely by men, with the females and sometimes children participating. This has implications for virus spread since passion fruit viruses can be transmitted through grafting and mechanical inoculation (Fischer & Rezende, 2008). Sensitization or training in disease management should, therefore, target both female and male household occupants. Agronomic practices such as fertilizer application and manure addition should also be encouraged since they boost plant tolerance to disease (Dordas, 2008). Slashing and weeding are imperative in ridding passion fruit of weeds to minimise competition for water, nutrients, space, pests and diseases. Spraying helps farmers to manage fungal and bacterial diseases, as well as pests. Generally, the agronomic practices enhance passion fruit production.

Major passion fruit production constraints and their mitigation strategies

Diseases (99%) followed by insect pests (57%) were reported as the key constraints hindering passion fruit production in the Central region (Figure 1). This is in agreement with previous studies that mention selected diseases followed by pests as key biotic production constraints, which also reduce passion fruit productive life and yield (Fushimi *et al*., 2001; Wangungu *et al*. 2010). Key diseases comprised of virus infections (100%), wilts (73%) and other diseases that cause fruit disorders such as fruit spots, rots and abortion (Figure 2). Studies conducted in Kenya amongst passion fruit growers also found these diseases as important production constraints (Mbaka *et al.*, 2006).

Other constraints mentioned included: poor supply of agro-inputs (30%), inadequate markets (22%), low market prices (21%), inadequate extension services, lack of planting materials, drought, land shortage and low yields.

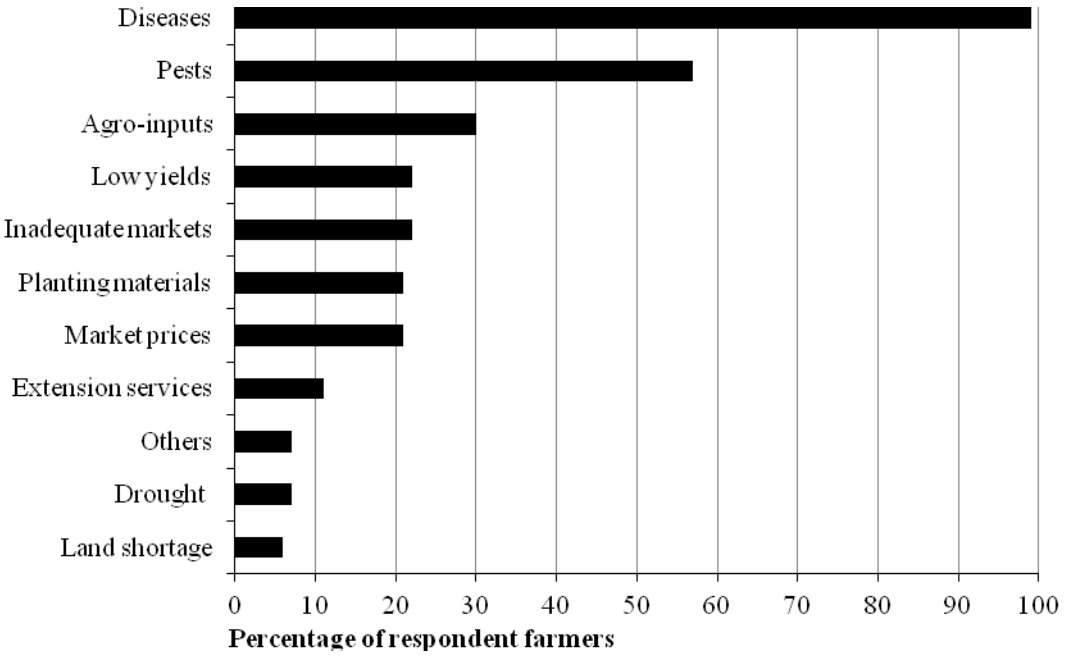


Figure 1: Major constraints in passion fruit production in Central Uganda

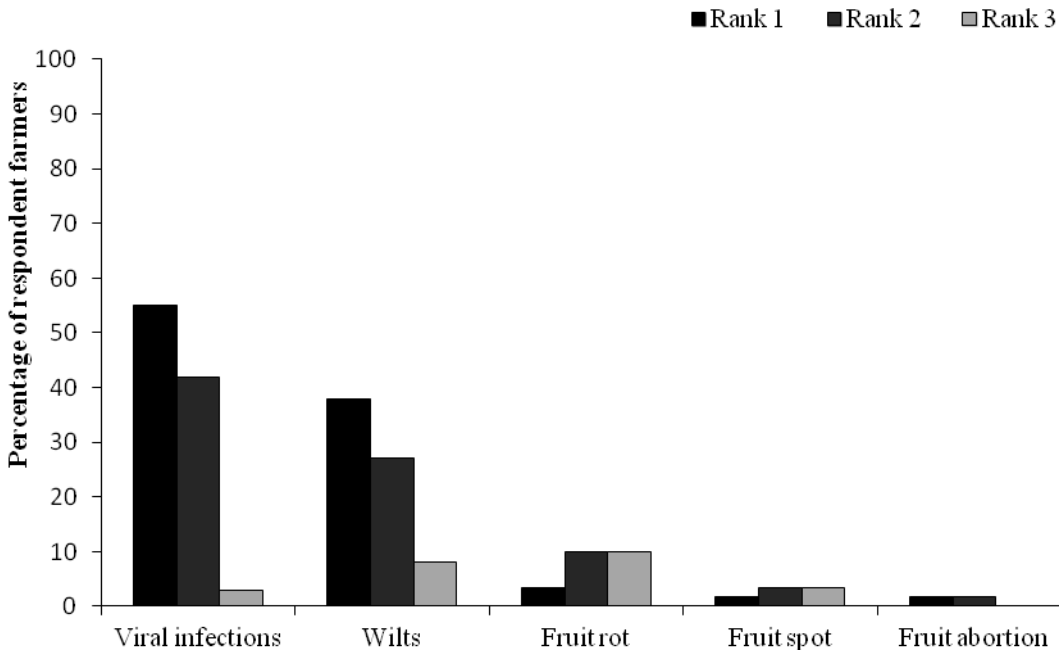


Figure 2: Farmer ranking of major diseases infecting passion fruit according to importance

Most of the farmers were not applying any mitigation strategies to manage the various constraints experienced, which is not surprising since similar observations have been made among passion fruit farmers in Kenya (Amata *et al*., 2011). However, chemical sprays and physical pest destruction were suggested by 33%, and 26% of the farmers as interventions for diseases and pests respectively. Passion fruit wilts in particular, were managed by chemical control and roguing of symptomatic plants by 35% and 27% of the farmers respectively. Farmers had no intervention strategies for diseases associated with fruit disorders. This implies that farmers have a knowledge gap since majority of diseases affecting the fruit can be managed by chemical sprays among others (Amata *et al*, 2011). Whereas chemical control were suggested as a control measure for passion fruit wilts, use of resistant rootstocks is better, considering that the diseases are soil borne (Njuguna *et al.*,2005).

Five percent (5%) of the farmers had their own nurseries to mitigate lack of planting materials. Uganda doesn't have formal seed systems for most vegetatively propagated crops; as such, farmers are often exposed to planting material infected with fungal and virus diseases during periods of scarcity. It is not, therefore, surprising that they have developed mechanisms of generating their own planting material.

Farmers' knowledge and perception of passion fruit virus diseases

Farmers were able to recognise virus disease symptoms. Seventy three percent of the farmers described them using words in their local language that translated to; leaf curling, chlorosis, stunted shoot tips and fruit woodiness. Twenty seven percent of the farmers were ignorant of virus disease symptoms and likened them to fruit rot, patches on leaves, fruit spots, withering of leaves and the plant. Regardless of knowledge on symptoms, more than half (52%) of the farmers were unaware of the cause of virus diseases. Forty eight percent of the farmers, who were aware of the cause, mentioned insect pest damage (32%), weather changes (8%), infected planting materials (5%) and soil contamination (3%). Despite the affirmation of virus diseases importance by the majority (80%) of farmers, only a minority employed control strategies. Pesticide application, pruning and roguing of symptomatic plants were practiced by 23%, 7% and 7% of the farmers for management of virus infections.

It was rather unfortunate that these farmers applied insecticides and fungicides heavily in the hope that the virus symptoms like leaf curl would disappear. This implies that farmers are oblivious of the fact that chemicals don't cure virus infection (Agrios, 2005). Roguing has been found to be effective if conducted after systemic inspections during the first five months after transplanting (Gioria *et al*., 2000). A small number of farmers pruned off symptomatic branches, implying that they were unaware of the systematic nature of virus infections (Thresh, 2006).

Knowledge of virus disease causes was weakly influenced by the farmers' level of education ($X^2 = 12.05$, $P < 0.001$) though not linked to production experience ($X^2 = 0.601$, $df = 1$, $P > 0.05$). Similarly, there was no relationship between famers' knowledge of virus disease causes and their age, production experience and passion fruit acreage (Table 2). This was not surprise considering that most of the farmers had attained only primary level. The lack of a relationship between knowledge of virus diseases causes and management may imply that farmers' randomly apply different control practices in a hope that the disease will be curbed. This emphasises the need for educating, sensitizing and equipping farmers

with the necessary pests and diseases management skills.

Farmers reportedly acquired virus disease knowledge from various sources including; own experience (40%), fellow farmers (20%) and extension services (10%). About 27% of the farmers were ignorant of management strategies. Management of virus disease was weakly associated to the farmers' level of education (X^2 = 4.342, df = 1, P < 0.05) although it was not influenced by production experience (X^2 = 0.287, df = 1, P > 0.05). There was no relationship between understanding of virus causes and management of the diseases (X^2 = 2.58, df = 1, P > 0.05). Farmer to farmer interaction was the main source of farmers' knowledge of virus diseases. This supports the relevance of rural social networks in improving farmer knowledge and capacity (Pretty *et al*., 2011) to manage disease.

Farmers' perception of mulching and weeding as alternative management strategies

More than half (58%) of the farmers, expressed interest in adoption of mulching as a cultural practice in management of virus diseases. Straw mulch and crop debris were used by 40% and 15% of the farmers, while only 3% used both straw mulch and crop debris. The mulch was sourced from own fields and bushes by 35% and 23% of the farmers respectively. Farmers' willingness to adopt mulch was due to the benefits associated with it, including: moisture conservation (30%), soil fertility improvement (18%), weed suppression (7%) and soil erosion reduction (3%). Of the 42% farmers unwilling to adopt mulching, 15% mentioned that mulch attracts termites, 13% believed that it hinders intercropping, 8% that mulch is labour intensive and 5% thought that mulch interferes with plant growth.

Farmers were further asked to give their perceptions on particular aspects of mulching as a probable management strategy for passion fruit viruses. More than half (60%) of the farmers affirmed that mulch is readily available at a minimal and affordable cost. Sixty eight percent (68%) of the farmers had knowledge on mulch use and felt mulch use was convenient. Almost all the farmers (92%) acknowledged mulch as an effective weed suppressant. Unfortunately, 58% of the farmers considered mulch as ineffective in management of pests and diseases (Table 3). Farmers' willingness to adopt weeding and mulching as possible management strategies if proven to be effective may be because of the good attributes associated with the practices in terms of increasing yield and quality of produce (Bhardwaj, 2013). Adoption of mulching implies that farmers would have to shift to better organized fields and probably sole cropping.

During the survey, farmers' fields were toured to confirm farmers' recognition and knowledge of disease symptoms. A large number of virus disease symptomatic plants were observed in most of the fields though disease incidence and severity were not scored. It would have been interesting to compare disease incidence and severity with the symptomatic intercrops and weed species for any meaningful relationship; and correlation of the different passion fruit production systems and practices with disease incidence and severity. This study only looked at the central region. Further studies can explore other agro-ecological regions.

Conclusion and recommendation

The study results affirm that passion fruit virus diseases are an important production constraint in Uganda. Although farmers are aware of the virus diseases, they have no effective management strategy for the diseases. Farmers, who attempt to manage the viruses,

do so without knowledge on disease dynamics, rendering their efforts futile. There is poor understanding of the cause, transmission and spread of passion fruit viruses. It is, therefore, recommended that farmers are sensitized on the cause, means of transmission and spread of virus diseases, as an initial step in curbing the diseases.

The willingness of farmers to adopt weeding and mulching as potential management strategies portrays their need for a solution to the disease problem. This is because adoption of such strategies requires farmers to change their production system from intercropping to sole cropping; a bargain farmers were willing to make. Further research on the efficacy of these technologies in management of virus diseases in passion fruit is required.

Table 2: Relationship between independent variables and virus disease knowledge

	Virus causes knowledge					
	Mean		SD		t(58)	p value
Variable	1	2	1	2		
Age	36.83	38.57	13.17	11.31	-0.547	0.587
Passion fruit acreage	1.13	1.03	1.17	1.07	0.131	0.724
Production experience	6.133	5.433	5.85	5.99	0.458	0.649

1 Knowledgeable farmers, 2 Non-knowledgeable farmers, n = 60

Table 3: Farmers' perception on mulching as a virus control strategy in Central Uganda

Parameter	Perception	n(%)
Mulch availability	Available	36(60)
	Not available	24(40)
Cost of mulch	High cost	17(28)
	Affordable	21(35)
	No external cost	22(37)
Application cost	High cost	17(28)
	Affordable	6(10)
	No external cost	34(57)
Knowledge on use	Knowledgeable	41(68)
	Limited	19(32)
Convenience of use	Convenient	41(68)
	Not convenient	19(32)
Suppresses weeds	Suppresses	55(92)
	No effect	5(8)
Controls insect pest and diseases	Effective	25(42)
	Ineffective	35(58)
Labour requirements	Labour intensive	36(60)
	Minimal	24(40)

n (%) is frequency and percentage per respondents

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