

The Challenges and Economic Importance of Pests as it Affects Sustainability of Horticultural Farmers of Thulamela Municipality in Vhembe District of Limpopo South Africa

Rendani Thovhogi¹, Elliot M. Zwane² and Johan A. Van Niekerk³

¹Centre for Sustainable Agriculture, Rural Development and Extension, University of the Free State, Box 9300, Bloemfontein, South Africa

²Centre of Rural Community Empowerment, School of Science and Environmental Sciences, Faculty of Science and Agriculture, University of Limpopo, Private Bag x 9487, Polokwane, 070, South Africa.

³Centre for Sustainable Agriculture, Rural Development and Extension, University of the Free State, Box 9300, Bloemfontein, South Africa

Abstract

The fruit and vegetable industry is threatened by many different types of pests; these pests negatively impact the industry. Pests such as fruit flies play a major role in reducing the quantity and quality of fruits and vegetables by threatening their production and marketability. The economic importance of the horticultural crops is also affected. The study targeted a population of 133 smallholder farmers that produce fruits and vegetables in the Thulamela Municipality. The study's objective was to investigate the challenges and economic importance of pests as it affects the sustainability of horticultural farmers of Thulamela Municipality in Vhembe district of Limpopo, South Africa. The majority (99%) of the respondents indicated that fruit flies affect their income because fruit flies cause loss of marketable products; sometimes, this is exacerbated by market restrictions, high production inputs, production of poor quality products, etc., the number of products produced. The study concludes with the following recommendations; firstly, there is a need to develop more adaptive and sustainable pest management strategies that would not require farmers to spend more money on production inputs. Secondly, there is a need to develop and disseminate information on quarantine pest and another pest of concern; disseminating information can do this to farmers through mass media such as radio programs and TV channels, and other relevant platforms.

Keywords: Pest, quarantine pest, pest constraints

I. INTRODUCTION

This paper focuses on pests' challenges and economic importance as it affects horticultural farmers' sustainability in Thulamela Municipality. Indigenous and quarantine pests cause a lot of challenges to the fruit and vegetable industry. Pests can cause constraints such as food insecurity, loss of

market or market restrictions, high costs of production inputs, low farm income, production of poor quality products, affect the number of products produced, and the economy. This paper aims to investigate the challenges and economic importance of pests as it affects the sustainability of horticultural farmers of Thulamela Municipality in Vhembe district of Limpopo, South Africa.

Fruit flies are the most destructive pests of fruit and vegetables [9]. The difficulty in controlling fruit flies causes huge yield losses in fruit and vegetable crops. Fruit flies reduce the quantity and quality of fruits and vegetables by threatening their production and marketability. This has a big impact on the international and domestic trade of these crops, and it also affects the income of producers and the economy.

According to [1], a number of people such as exporters, farmers, plant protection, and quarantine personnel distinguish fruit flies as one of the most serious pests that impact trade and horticultural production. As the fruit approaches the ripe stage of maturity, losses due to fruit flies, become greater. When it comes to the importation of fresh produce, the European Union (EU) impose strict quarantine measures such that the detection of only one fruit fly larva at the port of entry of a destination country leads to interception, confiscation, and destruction of the entire consignment and a possible ban for the exporting country. According to [25], annual economic losses of more than USD 42 million in Africa and USD 1 billion worldwide have been estimated from these losses. Most Sub-Saharan Africa countries have been banned from exporting their mangoes to markets in the EU and the United States of America. The economic damage caused by fruit fly infestation in Africa became worse when South Africa banned imports of mangoes and avocados from Kenya and imports of mangoes, bananas, and citrus fruits from Mozambique [20]; [23].



According to [8], many fruit flies of economic importance in the tropics and subtropics region are in the genus *Bactrocera*. [1] indicated that fruit flies' economic importance is derived from direct losses in production and lost market opportunities, and the trade restrictions imposed on fresh produce by importing countries. There are also pest surveillance costs, eradication of quarantine pests, and field control costs of existing pests. Plant pests may be introduced into a new area/country through natural migration, legal trading of agricultural produce, unintentional introduction aided by travelers crossing international borders with host commodities in their baggage, and pests acting as hitchhikers on cargo [5]. Some of these pests cause irreparable damage to the natural ecosystems and economic losses due to crop damage, pests control programs, and restrictions imposed on trade.

According to [3], the detection of *Bactrocera invadens* in Mozambique in 2007 led to importing fruit and vegetables imposing quarantine measures, leading to international markets' loss. [4] indicated that the South African market's temporary closure for three weeks in October 2008 resulted in the loss of about 2.5 million U.S. dollars. According to [13], the frequent utilization of insecticides in controlling fruit flies in fruits and vegetables has not resulted in the pest's sustainable management. Problems associated with the use of chemicals to control pests result in many problems being experienced by farmers. Some of the problems are: there are many residues of insecticides in crops, health problems for farmers, contamination of water and soil, insecticide resistance development, and decrease in the populations of the natural enemy of the pests.

II. RESEARCH METHODOLOGY

A. Study area

The study was conducted in the Limpopo Province of South Africa and was focused on the Thulamela municipality - Vhembe District Municipality. Thulamela Municipality is situated in the Vhembe district, and it covers 2893.936 km²/ 2893 393 hectares [28]. Out of the four municipalities in the district, Thulamela is the smallest, making up 10% of its geographical area. However, it is the largest municipality in the province in terms of the population [27]. Fruits and vegetables produced in the municipality include mango, avocado, banana, litchi, tomato, pepper, and pumpkin. Thulamela municipality has three service centers (namely: Thohoyandou, Matangari, and Khumbe) where mixed farming is practiced. The study only focused on the Thohoyandou Service center

B. Sample size

The study was conducted on 133 smallholder farmers producing fruit and vegetables. Table 1 shows the sample size of the study.

Table 1. Sample size calculated and determined using Raosoft sample size calculator

Name of service center	Population	Recommended sample size	Responses received
Thohoyandou Service centre	417	201	133
Total	417	201	133

Source: Own study

The producers' sample size was calculated using a Raosoft sample size calculator [22], giving a confidence level of 95% and a margin of error of 5% (Table 1). The total sample size calculated was 201 but could not be achieved due to the challenge of the Coronavirus (COVID 19) epidemic in the country. Some of the rules of COVID 19 included staying at home, and only essential workers were allowed to travel to work, and people who wanted to purchase essential goods; interprovincial travel and all public gatherings were also not allowed.

C. Data collection

The data was collected from farmers that produce fruit and vegetables in the Thohoyandou service center, and a structured questionnaire was used. The questionnaire was tested before the main data collection took place, and some changes were made to the questionnaire. The gathered data was captured and manipulated using statistical software. In terms of ethical considerations, the respondents were assured that confidentiality would be maintained.

III. RESULTS and DISCUSSION

This section presents the study's findings, which covers the demographic details and the challenges and economic importance of pests as it affects sustainability.

A. Demographic characteristics of farmers

The first demographic characteristic is gender. According to [11], gender is defined as the social roles and identities associated with what it means to be a man or a woman in a given society. The study results showed that 60.9 % of the respondents were males while 39.9% were females. This showed that in the area, fruit and vegetable production by smallholder farmers is dominated by males. Women play a major role in the production of food. In Africa, 60 to 80% of smallholder farmers are women and produce 90% of food in Africa and about half of all food globally [10].

According to [26], farmers' managerial skills get improved as they age and gain experience, which may contribute to

farmers becoming more productive. The results showed that 59.4% of the respondents were above the age of 51 years, while 25.6% of the respondents were between the age of 36 and 50 years old. Knowledge and skills in agriculture (e.g., production, operation, and management) increase with age [14].

According to [2], most smallholder farmers are uneducated, with poor technological skills, which can be a challenge for them to access useful formal institutions that disseminate technological knowledge. In terms of the level of education, even though the majority (42.1 %) of the respondents had attended school up to the secondary level, it was very interesting to find out that 14.3% of the respondents had tertiary qualifications. Of the 14.3% of respondents who had tertiary qualifications, the majority were youth. This meant that there is only a small percentage of youth involved in farming and that there is still a lot of work to be done to get youth to be involved in farming. According to [18], retaining youth in agriculture can enable them to bring in new ideas and embrace new farming technologies and business methods to take agriculture higher.

B. The impact of fruit fly infestation on farmer's income

According to [12], fruit flies' economic importance includes direct losses and increased production costs because of suppression actions and loss of export markets. Respondents were asked about the impact of fruit fly infestation on their income. The findings are presented in Figure 1.

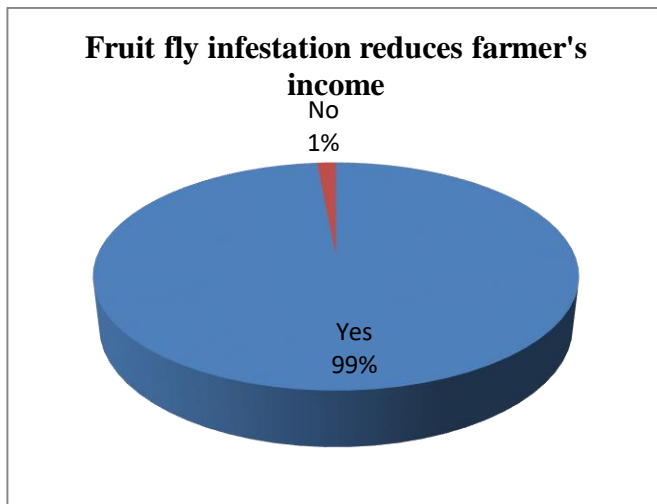


Fig. 1 Fruit fly infestation reduces farmer's income
(Source: Own study)

Figure 1 shows that 99% of the respondents indicated that fruit fly infestation does affect their income because fruit flies cause many negative issues such as loss of market/market restrictions, high costs of production inputs, production of poor quality products, affect the number of products produced. According to [24], Africa's mango production is considered to be below its potential due to the

increase in production costs and the reduction of the quality and quantity of marketable produce due to fruit flies. Fruit flies have a wide host range of soft, fleshy fruit and vegetables and can lead to direct losses of about 30 to 80% throughout the season, depending on the variety and locality [19].

C. Are fruit flies a threat to horticulture?

According to [29] in East, Central, and West Africa, fruit flies are major threats in horticultural production, causing substantial losses to produce. Participants were asked to indicate whether fruit flies are a threat to horticulture or not. The results are presented in Figure 2.

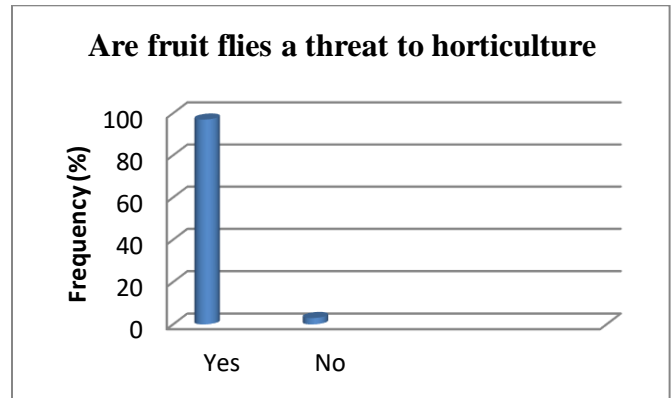


Fig. 2 Are fruit flies a threat to horticulture (Source: Own study)

Figure 2 shows that 97% of the respondents agree that fruit flies are a threat to horticulture; the fact that 97% of the respondents agree that fruit flies are a threat to horticulture indicates that fruit flies are causing problems to the farmer's produce. This shows that fruit flies are a major threat to the horticultural industry as they cause direct and indirect damage.

D. Do you think fruit flies cause food insecurity?

Throughout the world, food security is a challenge in such that "zero hunger" has been listed as one of the sustainable development goals. Respondents were asked whether they think fruit flies cause food insecurity. The findings are presented in Table 2.

Table 2. Do you think fruit flies cause food insecurity
(n=133)

Do you think fruit flies cause food insecurity	Frequency	Percentage
Yes	90	67.7
No	43	32.3
Total	133	100

Source: Own study

Table 2 shows that the majority (67.7%) of the respondents agree that fruit flies cause food insecurity; this might be due to the fact that female fruit fly lays eggs under the skin of the fruit, causing infested fruit to rot very fast and this results in considerable losses. According to [7], fruit flies can cause loss of production due to fruit rot and ultimately threatens food security.

E. Can fruit flies cause market restrictions?

Fruit flies reduce the quantity and quality of fruit and vegetables by threatening their production and marketability. According to [7], fruit flies can cause market bans or restrictions. Farmers were asked whether fruit flies can cause market restriction. The findings are presented in Figure 3

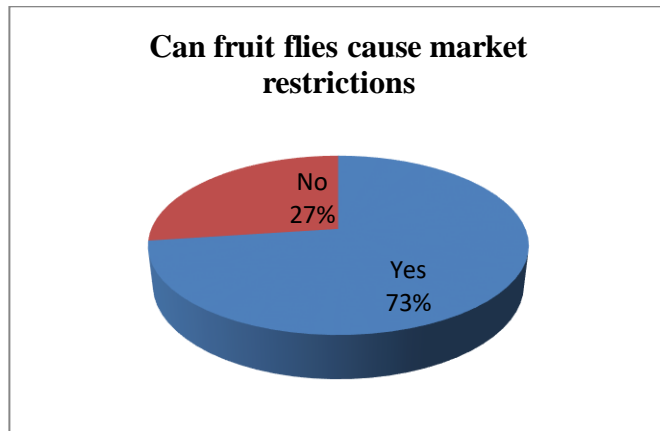


Fig. 3 Can fruit flies cause market restrictions (Source: Own study)

Figure 3 shows that the majority (73%) of the respondents agree that fruit flies cause market restrictions. This might be so because fruit flies cause the fruit to rot and affect the fruit's quality and quantity and make fruit unmarketable. There are international and national standards that farmers need to comply with when they produce the market (export and local market). This means that if farmers produce low-quality products that have been damaged by pests; they won't be able to send them to the market, the reason being unable to meet the required standard. Farmers have to comply with the prescribed national standards to take their produce to local markets. In South Africa, the sale of fresh vegetables is governed by Regulation 364 of the Agricultural Product Standards Act of 1990. The same Act, namely Act No. 119 of 1990) also prescribes the compliance of marketing of vegetables with regard to key elements such as grading, packing, and marking requirements. For the export of fruit such as citrus or vegetables such as *Capsicum annuum*, exporters have to comply with all the importing country's phytosanitary requirements.

F. Do fruit flies infestation cause fruit to fall prematurely?

A number of factors can cause fruit to fall prematurely, and infestation by fruit flies is one of the causes. This is

supported by [21] who indicated that fruit infested by fruit flies often drop prematurely. Respondents were asked to indicate if fruit flies cause the fruit to fall prematurely. The results are presented in Figure 4.

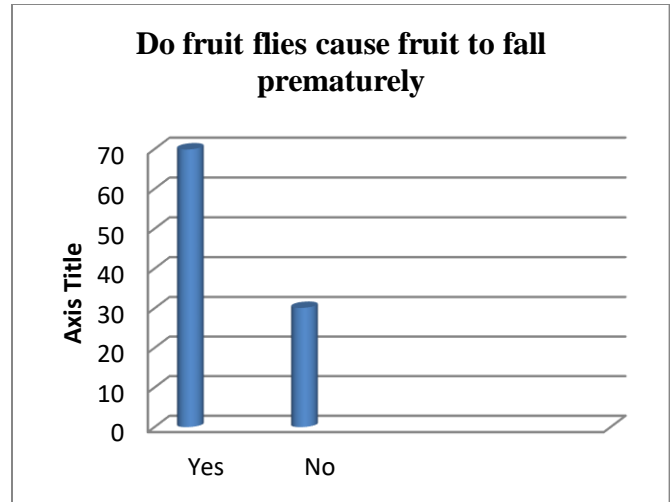


Fig. 4 Do fruit flies infestation cause fruit to fall prematurely (Source: Own study)

Figure 4 shows that the majority (69.9%) of the respondents agree that fruit flies cause fruit to fall prematurely, fruit flies attack fruits when they are beginning to ripe, and harvesting fruit like mangoes before they get ripe is recommended as a control method.

G. Does fruit fly affect humans or animals?

[12] indicated that fruit flies are one of the most economically important pests of fruit throughout the world. Respondents were asked whether fruit flies affect humans or animals; the results are presented in Table 3.

Table 3. Does fruit fly affect human or animals (n=133)

Do fruit flies affect humans or animals?	Frequency	Percentage
Yes	8	6
No	125	94
Total	133	100

Source: Own study

Table 3 gives a good picture as it shows that majority (94%) of the respondents are aware that fruit flies affects fruit and vegetables and not human and animals. According to [19], fruit flies have a wide host range of soft, fleshy fruit and vegetables. According to [6], the Oriental fruit fly is a polyphagous species with more than 200 host species belonging to more than 26 plant families; these pests are mangoes and guavas.

H. Quarantine pests

According to [16], a quarantine pest is ‘a pest of potential economic importance to the area endangered thereby and not yet present there, or present but not widely distributed and being officially controlled’. Respondents were asked to select quarantine pests from the three pests provided; the findings are presented in Table 4.

Table 4. Quarantine pests (n=133)

Quarantine pests	Frequency	Percentage
Oriental fruit fly	19	14.3
Mediterranean fruit fly	13	9.3
Whiteflies	45	33.8
All of the above	56	42.1
Total	133	100

Source: Own study

The results above are a concern as most (42.1%) of the respondents indicated that all of the three pests listed in Table 4 are quarantine pests of which is not true. This means that farmers are still not able to distinguish between quarantine pests and common local pests. Only 14.3% of the respondents selected the Oriental fruit fly (OFF), a quarantine pest that originated in Asia. According to [15], OFF can infest different commercial fruit crops, and it is a quarantine pest of Asian origin. Since most of the respondents are still not able to distinguish between quarantine pests and common local pests, there is a need to conduct more awareness training on quarantine pests.

I. Constraints caused by pests

The production and marketability of fruits and vegetables are threatened by fruit flies as they reduce the quantity and quality of produce [17]. Respondents were asked to indicate the constraints that are caused by pests. The findings are presented in Figure 5.

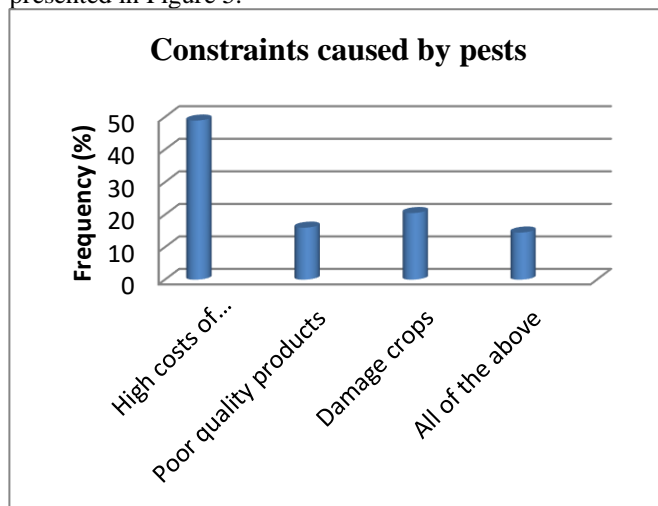


Figure 5: constraints caused by pests (Source: Own study)

Figure 5 does not give a good picture as it shows that pests are causing a lot of challenges for farmers. The majority (48.9%) of the respondents selected high production inputs as constraining caused by pests. According to [12], increased production cost resulted from suppression actions and loss of export markets; and direct losses are some of the economic impacts of fruit fly species.

IV. CONCLUSION and RECOMMENDATIONS

A. Conclusion

Pests of economic importance such as fruit flies are a major threat to the fruit and vegetable industry. The damage and economic impact of fruit flies should be of great concern to the fruit value chain. Smallholder farmers are highly affected by these pests as they have limited resources. Fruit flies affect both international and domestic markets as they affect the quantity and quality of products produced. The majority (99%) of the respondents indicated that fruit flies affect their income because fruit flies cause loss of market on the one hand and the other hand, market restrictions, high costs of production inputs, production of poor quality products and affect the number of products produced. The study results showed that 42.1% of the respondents could not distinguish between quarantine pests and common local pests, so there is a need for more awareness training on these pests. It is very important that information on new pests or pest outbreaks and actions that farmers need to take to protect their crops be shared with farmers on time; this can help improve fruit production by smallholder farmers.

B. Recommendation

Based on the findings of the study, the following recommendations are presented:

- There is a need to develop more adaptive and sustainable pest management strategies that will not require farmers to spend more money on production inputs.
- There is also a need to develop and disseminate information on quarantine pests and other pests of concern, and this can be done through a number of methods such as the following: by disseminating information to farmers through mass media (radio/TV), print, and online media, demonstrations, agricultural shows, plant health clinics, workshops, study groups, information days, and farmer's field schools.

REFERENCES

- [1] Allwood A.J. and Leblanc L., 1997. Losses Caused by Fruit Flies (Diptera: Tephritidae) in Seven Pacific Island Countries.
- [2] Baloyi J.K., 2010. An analysis of constraints facing smallholder farmers in the Agribusiness value chain: A case study of farmers in the Limpopo Province. University of Pretoria
- [3] Correia A.R.I., Rego J.M. and Olmi M., 2008. A pest of significant economic importance detected for the first time in Mozambique: *Bactrocera invadens* Drew, Tsuruta & White (Diptera: Tephritidae: Dacinae). *Boll. Zool. Agr. Bachic. Serie II*, 40(1): 9-13

- [4] Cugala D.R., 2011. Surveillance, Management and Control strategies of the invasive fruit fly *Bactrocera invadens* in Mozambique. Workshop presentation about Fruit flies in Mozambique. Pemba 23 - 24th March 2011.
- [5] Department of Agriculture, Forestry and Fisheries, 2013. The South African Emergency Plant Pest Response Plan. [viewed on 15 October 2020]. Available from: <https://www.nda.agric.za>
- [6] Department of Agriculture, Forestry and Fisheries, 2018. Action plan for the control of Oriental fruit flies *Bactrocera dorsalis* (Hendel). [viewed on 31 October 2020]. Available from: <https://www.nda.agric.za>
- [7] Department of Agriculture, Forestry and Fisheries, 2014. Invader fruit fly (*Bactrocera invadens*) control measures in South Africa. [viewed on 02 July 2020]. Available from: <https://www.nda.agric.za/Doadev/Sidemenu/Planthealth/Docs/Invader%20fruit%20fly.Pdf>
- [8] Drew R.A.I., Rodgers D J., Vijaysegaran S., and Moore C.J., 2008. The mating activity of *Bactrocera cacuminata* (Hering) (Diptera: Tephritidae) on its larval host plants *Solanum muaritanum* Scopoli southeast Queensland. *Bulletin of Entomological Research*, 2008, 98(1):77-81.
- [9] Ekesi, S., Billah, M.K., Nderitu, P.W., Lux, S. and Rwomushana, I., 2009. There is evidence for the competitive displacement of *Ceratitidis cosyra* by the Invasive fruit fly *Bactrocera invadens* (Diptera: Tephritidae) on mango and mechanisms contributing to the displacement. *Journal of Economic Entomology*, 102(3):981- 991.
- [10] Farming First, 2013. Gender. [viewed 10 October 2020]. Available from: <https://farmingfirst.org/gender/>
- [11] Food and Agriculture Organization of the United Nations, 2014. Gender in Agriculture Closing the Knowledge Gap. [viewed 10 October 2020]. Available from: <http://www.fao.org/3/i8815en/>
- [12] Grové, T., De Jager, K., De Beer, M.S., and Hannweg, K., 2016. Indigenous host plants for economically important fruit fly species in South Africa. *Agricultural Research Council - Institute for Tropical and Subtropical Crops*. [viewed 31 October 2020]. Available from: www.avocadosource.com > SAAGA_2016_39_PG_019
- [13] Guamán, V., 2009. Monitoring and pest control of Fruit flies in Thailand: new knowledge for integrated pest management.
- [14] Guo G., Wen Q. and Zhu J., 2015. The Impact of Aging Agricultural Labor Population on Farmland Output: From the Perspective of Farmer Preferences. [viewed 10 October 2020]. Available from: <https://www.hindawi.com/journals/mpe/2015/730618/>
- [15] Hortgro, 2017. Monitoring - *Bactrocera dorsalis* (BD). [viewed 1 November 2020]. Available from: www.sun.ac.za > faculty > agri > ipm > Documents.pdf
- [16] International Plant Protection Convention, 2007. Glossary of phytosanitary terms. [viewed 04 May 2020]. Available from: www.ippc.int > ISPM_05_2007_En_2007-07-26.pdf
- [17] Mugure C.M., 2012. Economic assessment of losses due to fruit fly infestation in mango and the willingness to pay for an integrated pest management package in Embu district, Kenya.
- [18] Ntshangase, W.M., And Mkhwanazi, S., 2016. The sustainability of land reform growers through youth involvement. A case study of the North Coast of KwaZulu-Natal in South Africa. University of the Free State.
- [19] Otieno W., 2009. *Bactrocera invadens* in Kenya. In: *Fighting Fruit Flies Regionally in SubSaharan Africa*. Information letter No. 6, December. COLEACP, CIRAD.
- [20] Ravry, C., 2008. The situation in Botswana, Kenya, Mozambique, Namibia, Zambia, and Zimbabwe. In: *Fighting Fruit Flies Regionally in West Africa*. Information letter No. 7, December 2008. COLEACP, CIRAD.
- [21] Radonjić S., Hrnčić S. and Perović T., 2019. Overview of fruit flies important for fruit production on the Montenegro seacoast, BASE [En ligne], Volume 23(1): 46-56. [viewed on 26 September 2020]. Available from: <https://popups.uliege.be/443/1780-4507/index.php?id=17776>
- [22] Raosoft Database Sample Size Calculator. [viewed on 26 September 2020]. Available from: <http://www.raosoft.com/samplesize.html>
- [23] Rwomushana I., 2008b. Bioecology of the New Invasive Fruit fly *Bactrocera invadens* (Diptera: Tephritidae) in Kenya and its Interaction With Indigenous Mango-Infesting Fruit Fly Species. Unpublished Ph.D. Thesis, Kenyatta University, Kenya.
- [24] Sebstad J. and Snodgrass D., 2005. Assessing the impact of the Kenya BDS and the Horticulture Development Center Projects in the Tree Fruit Subsector of Kenya: Baseline Research Report. Report No 33.
- [25] Standards and Trade Development Facility, 2010. A co-ordinated multi-stakeholder approach to control fruit fly in West Africa. STDF Briefing No. 4 January.
- [26] Tauer, L. 1995. Age and Farmer Productivity. *Review of Agricultural Economics*, 17(1), 63-69. [viewed 10 October 2020]. Available from: <http://www.jstor.org/stable/1349655>
- [27] Thulamela Local Municipality, 2020. Thulamela Local Municipality Geography, History & Economy [viewed 16 January 2020]. Available from: <https://municipalities.co.za/overview/1135/thulamela-local-municipality>.
- [28] Thulamela Municipality IDP, 2019/2020 - 2021/2022. [viewed 22 June 2020]. Available from: <http://www.thulamela.gov.za/docs/idp/IDP.BUDGET%202019-20201june2019.pdf>
- [29] Van Mela, P., Vayssieres, J.F., Tellingén, E. Van Vrolijk, J., 2007. Effects of an African weaver ant, *Oecophylla longinoda*, in controlling mango fruit flies (Diptera: Tephritidae) in Benin. *Journal of Economic Entomology*, 100(3): 695-701.