RUFORUM Working Document Series (ISSN 1607-9345), 2019, No. 18 (1): 239 - 244.
Available from http://repository.ruforum.org

Research Application Summary

Effects of False Yam *(Icacina oliviformis)* tuber extracts at different soaking days on the mortality of Fall Armyworm (*Spodoptera frugiperda*)

Ibrahim, M.[1]& Quainoo, A. K. [1]
Department of Biotechnology, Faculty of Agriculture, University for Development Studies, P.O. Box 1882 Tamale, Ghana
Corresponding Author: muazibrahimgh@gmail.com

Abstract

Fall armyworm has been identified to be one of the most damaging insect pests that attack maize plants at different developmental stages. Laboratory studies were carried out at the University for Development Studies in Ghana to identify the effects of False Yam tuber extracts at different soaking days on the mortality of fall armyworm, in an attempt to find ecologically friendly control measure to the pest. Using the leaf dip method of treatment application, the mortality of fall armyworm (FAW) was significantly affected (P<0.005) by extracts obtained from the different number of soaking days of false yam tubers in water and duration of exposure of fall armyworm to the extracts. After 24hrs of treatment application, T4 (8 days soaking) recorded the highest percentage FAW mortality of 23.3% this was significantly different from T1 (8 days soaking) which recorded the least percentage FAW mortality of 3.33%. Both treatments T3 (4 days soaking) and T4 (6 days soaking) obtained from soaking false yam tubers in water for 6 and 8 days respectively recorded the highest percentage mean mortality of 100% each after 72hrs of fall armyworm exposure to the treatments. The different treatments recorded increased in FAW mortality as the duration of exposure of the FAW to the treatments increased, with 24hrs exposure time recording the least percentage mortalities. The study provides alternative measures to curb the devastating effects of FAW invasion in the field.

Keywords: Biopesticide, cereal crop, False yam, maize, pests

Resume

La chenille légionnaire d'automne (FAW) a été identifiée comme l'un des insectes ravageurs les plus nuisibles qui attaquent les plants de maïs à différents stades de développement. Des études de laboratoire ont été menées à l'Université des études sur le développement au Ghana afin d'identifier les effets des extraits de tubercules de fausses ignames à différents jours de trempage sur la mortalité de FAW, dans le but de trouver une mesure de contrôle écologique de ce ravageur. En utilisant la méthode d'application du traitement par trempage des feuilles, la mortalité de FAW a été significativement affectée (P<0,005) par les extraits obtenus à partir de différents nombres de jours de trempage des tubercules de fausse igname dans l'eau et de la durée d'exposition de la chenille aux extraits. Après 24 heures d'application du traitement, T4 (8 jours de trempage) a enregistré le plus haut pourcentage de mortalité de la chenille légionnaire d'automne, soit 23,3 %, ce qui est significativement différent de T1 (8 jours de trempage) qui a enregistré le plus faible

pourcentage de mortalité de la chenille légionnaire d'automne, soit 3,33 %. Les deux traitements T3 (4 jours de trempage) et T4 (6 jours de trempage) obtenus à partir de tubercules de faux igname trempés dans l'eau pendant 6 et 8 jours respectivement ont enregistré le plus haut pourcentage de mortalité moyenne de 100% chacun après 72 heures d'exposition de FAW aux traitements. Les différents traitements ont enregistré une augmentation de la mortalité de FAW au fur et à mesure que la durée d'exposition de la chenille aux traitements augmentait, le temps d'exposition de 24 heures ayant enregistré le plus faible pourcentage de mortalité. L'étude fournit des mesures alternatives pour limiter les effets dévastateurs de l'invasion de FAW dans les champs.

Mots-clés : Biopesticide, culture céréalière, Faux igname, maïs, ravageurs.

Introduction

Maize (*Zea mays*) is a cereal crop cultivated worldwide. Considering its high yield per hectare, easiness in cultivation and adaptability to diverse ecological zones, maize plays an important role in the livelihood of the African populace (Fandohan *et al.,* 2003). Like many other cereal crops, maize is often attacked by many pests and parasites both on-field and in storage. The primary causative agents of grain losses are often insects (Fandohan *et al.,* 2003). In West Africa, an estimated 25% of maize produced is damaged by insect pests before reaching the consumer (Baidoo *et al.,* 2010). One of the most economically important insect pests of maize in the African continent is the fall armyworm (FAW).

The fall armyworm is a polyphagous insect pest that is innate to the Americas. The insect feeds on more than 80 diverse crops including maize, and is the most destructive crop pest in the Americas (Abrahams *et al.,* 2017). In Africa, control of FAW has so far been largely dependent on the use of synthetic pesticide. Pesticides such as Endosulfan, Carbosulfan, Cyfluthrin, Methomyl, and Methyl-parathion, that are classified by World Health Organisation (WHO) and Food and Agriculture Organisation (FAO) as "Highly Hazardous Pesticide" (HHP). The application of these insecticides poses serious threats to not only human and animal well-being but also the environment (Prasanna *et al.,* 2018). It is therefore essential to develop different control measures with minimal threat to human health and the environment to control the FAW.

The application of biopesticides to cultivated fields is an alternative control method to combat pest infestation with very minimal toxicity to humans and the environment (Chandler *et al.,* 2011). Reports on the effectiveness of false yam extracts as biopesticide on cowpea aphids and sweet potato beetles have been documented by Amponsah (2012) and Alale *et al.* (2017). According to Alale *et al.* (2017), false yam is an economically affordable plant which can be used as a substitute biopesticide for conventional pesticides.

Material and Methods

Study area. The study was carried out in the Entomology Laboratory at the University for Development Studies, Ghana during the 2018 farming season. the Laboratory is located in Nyankpala situated within the Tolon District in the Guinea Savanna Agricultural zone with latitude 9° 15′` and 10° 02` North and Longitudes 0° 53′and 1° 25′ West. The temperatures of this area

range from 20˚C to 39˚C with a relative humidity of roughly 53% to 80% and an annual rainfall of 950 to 1200mm/annum (GSS, 2014).

Source of materials. Maize seeds (Wang Dataa variety) were acquired from Savanna Agriculture Research Institute (SARI), Tamale, Ghana. Fall armyworms at the 4th to 6th larval instar stage were handpicked from infested farms within the Nyankpala catchment area. False yam tubers were harvested from the wild at the Nyankpala Campus of the University for Development Studies. Subsquently, 30 black rubber containers (8L) were filled with sandy-loam soil and two maize seeds were sown in each of the containers. The setup was watered and kept at a safe place in the plant house. The maize was then grown for 5-7 weeks and the leaves were used as feed for the FAW larval instars.

In terms of treatment preparation, false yam obtained from the wild were chopped into pieces of about 2 cm and washed to remove sand and dirt surrounding them. Subsquently 2 kg of the chopped false yam pieces were weighed using a balance and 2L of water was added to the weighed sample in a clean rubber container. The soaked false yam were allowed to stand for 2, 4, 6, and 8 days to obtain the following concentration treatment T1, T2, T3, and T4, respectively. The solutions obtained, after removing the soaked tubers in water, were decanted into well-labeled bottles covered with lids. This was done 16-18 hours preceding treatment application.

Experimental design. Using the different treatments T1, T2, T3, and T4 of false yam tuber solutions, the effects of false yam tuber extract on the mortality of FAW of maize was evaluated in a Completely Randomized Design where the FAW larval instars were randomly assigned to the various treatments. The treatments were applied using an application method employed was the Leaf dip method with water only as a control.

In the leaf Dip Method of Treatment Application, maize leaves were cut into smaller pieces of about 10 cm in length, dipped in a single treatment for 2 mins and air-dried for 3 mins. Four of the treated leaves were placed in a transparent glass bottle and 10 of the larval instars were added to feed on the leaves. The bottle was enclosed with muslin held in position with a rubber band to prevent the escape of the FAW larval instars. The experimental setup was then replicated three times and this was done for all of the treatments using water as a control.

After 24, 48 and 72 hours of treatment application, data on mortality of FAW larval instars were recorded for the various treatments and were analysed using Genstat Discovery 12th edition at 5% significant level.

Results and discussion

There was a significant difference in the effects of false yam tuber extract from different soaking days on the mortality of the FAW at 24 hrs, 48 hrs and 72 hrs after treatment application (Table 1). Treatment 4 (8 days of soaking) recorded the highest mean mortality at 24 hrs and 48 hrs but the level of mortality was the same as Treatment 3 (6 days of soaking) at 72 hrs. The mean mortality for T4 was not significantly different from that of T3 for all of the different days of FAW exposure to the treatments. Also T1 recorded the least FAW mortality for the various times of treatment exposure but was not significantly different from T2 at 24 hrs and 48 hrs periods.

Table 1. Effects of different soaking days of false yam tuber extract on FAW mortality

Treatment (soaking period)	Mortality after 24 hrs (%)	Mortality after 48 hrs (%)	Mortality after 72hrs (%)
T1	3.33 ±3.33^{ab}	20.00±10.00^{ab}	50.00±5.80^{b}
T2	13.30±3.33^{abc}	40.00±5.77^{bc}	76.70±3.33^{c}
T3	20.00±5.67^{c}	53.30±3.33^{bc}	100.00±0.00^{d}
T4	23.30±6.70^{c}	63.30±12.02^{c}	100.00±0.00^{d}
Control	0.00±0.00^{a}	0.00±0.00^{a}	10.00±5.77^{a}
P Value	0.016	<0.001	<0.001
LSDα-0.05	14.09	23.95	12.43

Means with the same letter in the same column are not significantly different from each other at P<0.005

T1, T2, T3,T4=2,4,6 and 8 hours of soaking

Effects of treatments on the survival of fall armyworm of maize. The survival rate of FAW was significantly affected by the different number of soaking days of false yam tuber extract (P≤ 0.016). Survival rate decreased as the number of soaking days increased with T1 (extract obtained after two days of soaking false yam tuber in water) recording the highest rate of survival. Both T3 (6 days of soaking) and T4 (8 days of soaking) recorded the least (0%) survival at 72hrs after treatment application.

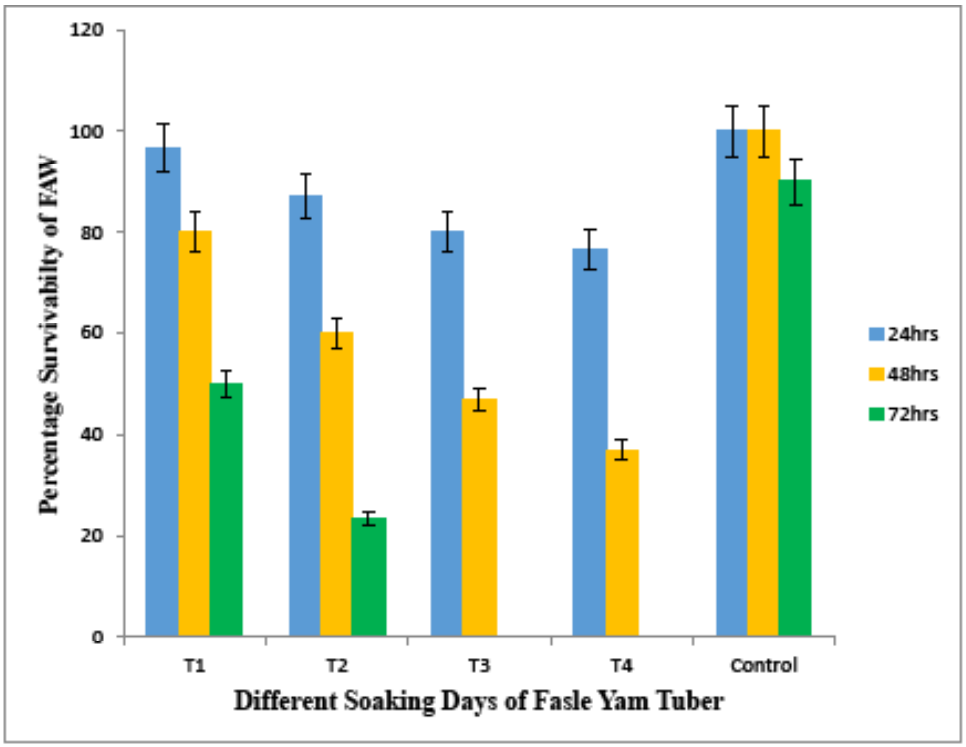

Figure 1. Effects of different soaking days of False Yam Tuber on the survival rate of fall armyworm

The present results indicate that false yam tuber extract causes a significant increase in mortality of FAW of maize. The result indicate that FAW mortality was proportionate to the number of soaking days of the false yam tubers in water, thus an increase in the number of soaking days of the false yam tubers from which treatment extracts were obtained led to a corresponding increase in the number of FAW deaths recorded after treatment application as shown in Table 1. The duration of exposure of FAW to the various treatments also significantly affected their mortality. The highest mortality of the FAW was recorded after 72hrs of treatment application in comparison to shorter durations.

The observed mortality of the FAW was as a result of the antifeedant effect of the tuber's extract may be due to starvation and subsequently the death of FAW. A report by Vanhaelen *et al.* (1987) indicated that compounds such as sitosterol 3-0-B-D-glucopyranoside, Icacenone, and sigmasterol 3-0-B-D-glucopyranoside are components of a group of compounds called tarpens that are inherent in the false yam plant. These compounds have insecticidal properties and limit the plant utilization as food. Also, an active and toxic compound called gum resin was reported by Fay (1987) to be a component of the false yam plant. The combined effects of these compounds may have resulted in the observed mortality of the FAW even though the effects were not immediate as FAW were seen actively moving around a few hours after treatment application.

The survival rate of FAW was significantly affected by the number of soaking days of the false yam tuber and the duration of exposure of FAW to the treatments. Higher survival rates were recorded for both lower number of soaking days of false yam tubers and lower time of exposure of FAW to treatments as shown in Figure 1. This observed effect may have been due to the low presence of active compounds against FAW in the extract obtained with the lower number of soaking days of false yam tubers and also delay in effects of these active compounds on the FAW. A similar occurrence of low concentration of active compounds and delay in the effects of false yam tuber extract on aphid mortality was reported by Alale *et al.* (2017).

Conclusion

The results indicate that aqueous false yam tuber extract has the potential to control FAW of maize. The study demonstrated the significant effects of false yam tuber extract at different soaking days on the mortality and survival rate of FAW.

Acknowledgement

We acknowledge the contribution and criticisms of students and staff of the Department of Biotechnology during the course of this study. This paper is a contribution to the 2019 Fifteenth RUFORUM Annual General Conference.

References

Abrahams, P., Bateman, M., Beale, T., Clottey, V., Cock, M., Colmenarez, Y. and Witt, A. 2017. Fall Armyworm: Impacts and implications for Africa. 1–144. https://doi.org/10.1564/v28

Alale, Y. T., Opoku, N. and Adarkwah, C. 2017. The efficacy of aqueous False Yam (*Icacina oloviformis*) tuber extract against cowpea aphids (*Aphis craccivora* Koch). *Journal of Young*

Investigators 32 (4): 22–24. https://doi.org/10.22186/jyi.32.4.22-24

Amponsah, E. K. 2012. Evaluation of *Icacina senegalensis* and *Jatropha curcas* extract for the management of sweet potato beetle *Cyclas* spp. (Coleoptera: Brentidae). Doctoral dissertation. 84pp.

Baidoo, P. K., Mochiah, M. B. and Owusu-Akwya, M. 2010. Levels of infestation on three different portions of the maize cob by the weevil *Sitophilus zeamais* (Motschulsky). *Journal of Science and Technology* 30 (3): 21–26.

Chandler, D., Bailey, A.S., Tatchell, G.M., Davidson, G., Greaves, J. and Grant, W.P. 2011. The development, regulation and use of biopesticides for integrated pest management. *Philosophical Transactions of the Royal Society B: Biological Sciences* 366 (1573): 1987-1998.

Fandohan, P., Hell, K., Marasas, W.F.O. and Wingfield, M .J. 2003. Infection of maize by Fusarium species and contamination with fumonisin in Africa. *African Journal of Biotechnology* 2 (12): 570-579.

Fay, J.M., 1987. *Icacina oliviformis* (Icacinaceae): A close look at an underexploited crop. I. Overview and ethnobotany. *Economic Botany* 41 (4): 512-522.

GSS. 2014. Population and Housing Census: District Analytical Report, Tolon District, Ghana.

Prasanna, B. M., Huesing, J. E., Eddy, R. and Peschke, V. M. 2018. Fall Armyworm in Africa: A Guide for Intergrated Pest Management. Feed the Furture. 120pp.

Vanhaelen, M., Planchon, C., Vanhaelen-Fastré, R. and On'Okoko, P. 1987. Terpenic constituents from *Icacina senegalensis*. *Journal of Natural Products* 50 (2): 312-312.