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Article

Integrated developmental and green social work field education to control fall armyworm infestation in maize crops in Malawi

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Abstract
In Malawi, fall armyworm (FAW) infestation in maize crops is a problem of public importance as it reduces maize yields and exacerbates household food insecurity. In addition to pest resistance, the use of synthetic pesticides to control FAW negatively affects the health of farmers and the environment. Biochemical pesticides from plants contain naturally non-toxic chemotypes and are effective in controlling pests. *Tephrosia vogelii* plants contain these bioactive phytocompounds that have pesticidal properties. Geographical location and plant species influence the occurrence of phytocompounds in *Tephrosia vogelii.* Farmers in Sub Sahara-Africa are using *Tephrosia vogelii* as a pesticide but there are mixed research findings regarding its effectiveness in controlling FAW pests. This study was informed by developmental and Green Social Work frameworks to compare the effectiveness of *Tephrosia vogelii* leaves extracts, Belt 480 SC, and soap solution in controlling FAW in maize gardens. The study employed a randomized complete block design with four replication gardens and was conducted from November 2022 to March 2023. A social work field education student was assigned to coordinate the project. The study affirmed that the sampled *Tephrosia vogelii* leaf extracts contained pesticidal chemotypes. The results of field gardens suggest that *Tephrosia vogelii* leaf extracts have similar potency to Belt SC 480 chemical pesticide. It has been identified that Boom detergent soap is not as effective as *Tephrosia vogelii* leaf extracts. The study has social work field education implications for empowering practicum students to gain community mobilization skillsets, to participate in environmental justice advocacy, and to uphold social work values.

Keywords
fall Armyworm, food security, *Tephrosia vogelii*, field education, developmental social work, Green Social Work, environment, Malawi

Résumé
Au Malawi, l'infestation des cultures de maïs par la chenille légionnaire d'automne est un problème d'importance publique car elle réduit les rendements du maïs et exacerbe l'insécurité alimentaire des ménages. Outre la résistance des ravageurs, l'utilisation de pesticides synthétiques pour lutter contre la chenille légionnaire d'automne affecte négativement la santé des agriculteurs et l'environnement. Les pesticides biochimiques issus de plantes contiennent des chémotypes naturellement non toxiques et sont efficaces pour lutter contre les ravageurs. Les

plantes *Tephrosia vogelii* contiennent ces phytocomposés bioactifs qui ont des propriétés pesticides. La situation géographique et les espèces végétales influencent la présence de phytocomposés chez *Tephrosia v*ogelii. Les agriculteurs d'Afrique subsaharienne utilisent *Tephrosia vogelii* comme pesticide, mais les résultats des recherches sont mitigés concernant son efficacité dans la lutte contre les ravageurs de la chenille légionnaire d'automne. Cette étude s'est appuyée sur des cadres de travail social vert et de développement pour comparer l'efficacité des extraits de feuilles de *Tephrosia vogelii*, du Belt 480 SC et d'une solution savonneuse pour lutter contre la chenille légionnaire d'automne dans les jardins de maïs. L'étude a utilisé une conception en blocs complets randomisés avec quatre jardins de réplication et a été menée de novembre 2022 à mars 2023. Un étudiant en formation en travail social a été chargé de coordonner le projet. L'étude a confirmé que les extraits de feuilles de *Tephrosia vogelii* échantillonnés contenaient des chémotypes pesticides. Les résultats des champs potagers suggèrent que les extraits de feuilles de *Tephrosia vogelii* ont une puissance similaire à celle du pesticide chimique Belt SC 480. Il a été identifié que le savon détergent Boom n'est pas aussi efficace que les extraits de feuilles de *Tephrosia vogelii*. L'étude a des implications dans le domaine de la formation en travail social. Il s'agit notamment de permettre aux étudiants en stage d'acquérir des compétences en matière de mobilisation communautaire, de défense de la justice environnementale et de valeurs du travail social.

Mots clés
chenille légionnaire d'automne, sécurité alimentaire, *Tephrosia vogelii*, éducation sur le terrain, pratique du travail social vert, travail social développement, Malawi

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Introduction

In 2016, farmers in Malawi reported an outbreak of a new pest infestation on cereal crops which entomologists established to be Fall Armyworms (*Spodoptera frugiperda*) (Durocher-Granger et al., 2018). Fall armyworms (FAW) are destructive crop insect pests that originated in the tropical and subtropical regions of the Americas. FAW migrated to Sub-Sahara African countries in early 2016, and by 2017, became an endemic pest in the region (Matova et al., 2020). The pest infests and feeds on important livelihood crops such as maize, sorghum, rice, millet, cotton, and many cereal-related species. FAW significantly undermine the quantity and quality of crop yields that have been found to diminish agricultural-related household and national socioeconomic development (Durocher-Granger et al., 2018). The control and management of FAW are proving unsuccessful in sub–Sahara Africa including Malawi for various reasons. For instance, the pest reproduces quickly and has a short lifecycle. In addition, the FAW moth morphology is adapted to speed migration and can fly up to 100 kilometers daily thus leading to uncontrollable widespread outbreaks (Matova et al., 2020).

Since September 2016, Malawi has recorded numerous FAW outbreaks that have contributed to a drastic reduction in maize yields. A study has shown that FAW infestation is contributing to approximately 12% losses (-130kg/ha) of maize yields every year in Malawi (Adan et al., 2023).

Maize is a top subsistence crop in Malawi, principally grown by smallholder farmers as a staple food. In the 1980s, the Malawi government adopted a global green revolution technology to increase maize production (Denning et al., 2009). Green revolution technology focuses on monocropping, the use of hybrid seeds, intensive use of chemical fertilizers, and pesticides. To promote wide adoption of green revolution technology, the Government of Malawi introduced a farm input subsidy program in 1994. The focus remained on hybrid maize seeds and chemical fertilizers (Denning et al., 2009). The green revolution technology undermines smallholder farmers' capability to invest in indigenous and agroecology technics that are resilient to climatic and economic shocks. Despite heavy investment in farm input subsidies, maize production by farmers continues to decline due to various abiotic and biotic stressors in Malawi (Burke et al., 2022). Among others, climate change-related agricultural shocks such as intermittent dry spells, rainfall variability, tropical storms, cyclones, diseases, and pest outbreaks are increasingly undermining small-scale maize production (Maganga et al., 2021; Makate & Makate, 2022). The current global economic shocks associated with the COVID-19 pandemic and the Ukraine-Russia war have contributed to hyperinflation of Malawi's local currency (Nasir et al., 2022). This has resulted in exorbitant prices for maize farm inputs and overall food supply (Arndt et al., 2023; Dzimbiri et al., 2022). The deterioration of maize production has rendered local farmers and the general public vulnerable to food insecurity. Consequently, the situation has negatively affected social and health interventions to improve child nutrition which is of concern to social workers and allied professionals (Chilanga & Chilanga, 2023; Riley & Chilanga, 2018).

Current evidence shows that farmers in Malawi are mainly using synthetic chemical pesticides with high toxicity to control FAW in maize fields (Phambala et al., 2020). The chemicals pose significant risks to the health of farmers in the form of skin and lung cancers. This is so as most farmers do not use personal protective equipment or application equipment when spraying. Farmers in Malawi are also reported to have limited knowledge of chemical pesticides that hinder correct FAW dose rates and discriminate spraying (Mkandawire, 2017). High concentration and indiscriminate use of synthetic chemicals to control FAW has been linked to an increased risk of insecticide accumulation in the environment. This poses great danger to birds, mammals, aquatic species, and pollinators (Tambo et al., 2020). In addition, there are verified reports that FAW are developing resistance to chemicals such as cypermethrin. The resistance is compelling farmers to intensively apply a cocktail of synthetic chemicals. The practice increases the accumulation of toxic residues in maize yields which present significant food poisoning concerns to consumers (Matova et al., 2020).

Due to the exorbitant cost of chemical pesticides, and FAW chemical resistance, many farmers have resorted to using desperate measures such as soap/laundry detergents and fish soup to control FAW in Malawi (Phambala et al., 2020). The potencies of these local pesticides are yet to be scientifically validated risking farmers to have minimal maize yields including environmental contamination. Therefore, identification and testing of lower-risk and cost-effective organic FAW control methods that are tailored to smallholder farmers are research priorities in Malawi. Globally, crop experts are recommending the use of organic pesticides (botanicals) due to their numerous benefits (Keerthi et al., 2023). These are biodegradable, less harmful to nontarget and beneficial insects, less expensive, and the plants are locally available. Hence, organic pesticides have the potential to adhere to social work principles of social and environmental justice which aim at preserving the ecosystem, reducing environmental health risks, and promoting human well-being (Dominelli, 2012).

Since Mary Richmond's time, the field of social work in the Western world has been applying empowerment-based perspectives in social work theory and practice to help vulnerable people and communities to work through challenges they face in everyday life (Agnew, 2004). These challenges mainly originate from capitalist economies that perpetuate socioeconomic inequalities. Of late, social workers are increasingly working with individuals and communities that are being affected by environmental crises and human-induced disasters such as floods, earthquakes, epidemics, and wars (Dominelli, 2012). There is a growing concern that social workers are not well equipped to practice with individuals and communities in the context of environmental crises due to limited climate change-related professional expertise (Wu & Greig, 2022). The related sentiment was raised by social work scholars in Africa (Mupedziswa, 2001). They observed that clinical-oriented Western social work models that are taught in African universities are incompatible with African challenges. The reasons are that African socioeconomic problems are driven by environmental change, cultural structures, and political maladministration (Mupedziswa, 2001). Hence, there is a call to recast social work curricula and research to incorporate innovative and pragmatic models that are tailored to address environmental-induced human problems. Green social work is one such progressive social work practice model that can be applied at micro and macro levels to mitigate environmental-related challenges (Dominelli, 2012). Green social work scholars actively organize multidisciplinary professionals and community members in the research and creation of innovative environmental crisis-related solutions. Such social work curricula have the potential to empower social work field education students and professionals to practice with individuals and communities that are prone to and affected by extreme events such as disasters (Dominelli, 2012). In Africa, such models are supposed to be routed in social development theories that focus on developmental approaches that place people and human rights at the center of community organizing (Chilanga, 2013). Hence, the goal of developmental social work in Africa is to address poverty, ensure that people have their social needs addressed in a just process (Mupedziswa, 2001).

In Malawi, there is a need for social work research that can integrate developmental and green social work frameworks to address crosscutting issues such as household food insecurity, HIV/AIDS, land degradation, and poverty that are of concern to smallholder farmers (Kerr et al., 2016). The pressing problem of FAW in Malawi provided the context for a multidisciplinary team composed of a social work scholar, a botanist, a biology research student, and social work field education student to test developmental and green social work models to control FAW in maize fields. The focus was to identify environmentally friendly, cost-effective, and locally available biochemical pesticides that can be tested by local farmers to control FAW in maize crop fields in order to contribute to sustainable livelihoods and human and environmental well-being.

Plant extracts from trees such as *Tephrosia vogelii*, neem, and *Ricinus communis* are known to have pesticide properties. The extracts are being widely tested in sub-Sahara African countries including Malawi as organic crop pesticides (Keerthi et al., 2023). It is documented that *Tephrosia vogelii,* more especially its leaves, contain bioactive phytocompounds that have pesticidal properties. However, research indicates that geographical location and plant species influence the occurrence of critical pesticidal compounds in *Tephrosia vogelii* which call for context-based validation (Mlozi et al., 2022). A study in Malawi has confirmed the effectiveness of *Tephrosia vogelii* in controlling common bean aphid but there are mixed results on its effectiveness in controlling FAW in maize crops (Phambala et al., 2020). Against this background, we applied an integrated developmental and green social work model in conducting field garden experiments to examine the efficacy of *Tephrosia vogelii* plant leaves extracts in controlling FAW in maize gardens. This study was conducted in rural areas of the Dowa district in central Malawi and had two specific objectives. First, we aimed at ascertaining the presence of flavonoids and rotenoids compounds in *Tephrosia vogelii* plants. These compounds have been widely tested to contain pesticidal properties. Second, we aimed at comparing the efficacy of *Tephrosia vogelii* plant extracts against commonly used FAW maize pesticides. These are Belt 480 SC, a synthetic pesticide, and Boom, a detergent soap.

Literature Review

Malawi is a small landlocked agri-based country in Sub-Saharan Africa. As of April 2023, Malawi was ranked the third poorest country in the world with $483 Gross Domestic Product (GDP) per capita (World Bank, 2023). It is estimated that 70% of Malawians are poor and live on less than the international poverty line of $1.90/day and that 51% of the population is not able to consume a minimum caloric intake of 2215 calories a day (World Bank, 2023). The World Bank poverty and equity report indicates that 23% of Malawians were experiencing acute food crises between October 2022 and March 2023 (World Bank, 2023). This was mainly driven by tropical cyclones, the COVID-19 pandemic, and the war in Ukraine (Food and Agriculture Organization, 2023). The high poverty level in Malawi is attributed to the fact that 85% of the population depends on rainfed subsistence farming for their livelihood (World Bank, 2023). Climate change in Malawi is evident as the mean annual temperature has increased by approximately 1% from 1960 and is predicted to rise further in the next decade (Kavwenje et al., 2022). Consequently, rainfed farming in Malawi is vulnerable to weather shocks such as erratic rainfall that is causing widespread recurring floods, periodic droughts, and the spread of pests and diseases. To support most Malawians to meet their socioeconomic development challenges and well-being, policymakers and community mobilizers need to support farmers to transform agricultural practices to be resilient to climate change-induced shocks (Warnatzsch & Reay, 2020).

Social workers are guided by the principles of social and climate justice, and they are committed to promoting community well-being and environmental sustainability through the Global Agenda for social work and social development (Jones & Truell, 2012). Hence, social workers in Malawi are duty-bound to mitigate the climate change-induced plight of Malawians by developing interventions with local communities to work towards sustainable solutions. Social work professionals in Malawi are working with individuals and communities that are experiencing food insecurity and economic distress due to climate change-related crises such as FAW infestation in maize crops. Similar to the global level, social work practitioners in Malawi have limited climate change-related knowledge because the social work profession and training have been ambivalent to the natural environment (Besthorn & Saleebey, 2003). Hence, green social workers are advocating for social work educators to incorporate environmental issues to equip students to practice with individuals, families, and communities that are affected by climate-related shocks (Dominelli, 2012).

In many countries in sub-Saharan Africa, there is a dearth of knowledge on how development-oriented green social work pedagogy can be integrated into the curriculum and how students can gain the required skillsets in Malawi (Arkert & Jacobs, 2023). This is the result of social work education and practice in the region being grounded in the Western framework that emphasizes neoliberal, individualistic, materialistic, and clinical paradigms while disregarding the needed person-in-environment perspective. A green social work curriculum has the potential to address climate change-related crises that farmers are encountering in Malawi as it is aligned with the three basic methods of practicing social work. Green social workers can apply social casework, group, and community development methods to understand and mobilize farmers' capacity to find cost-effective and environmentally friendly FAW control methods (Muchacha & Mushunje, 2019). Students can put into practice social work-related theories such as social learning theory, ecological system theory, empowerment theory, and development theory while working with farmers to find tailored solutions (Drolet et al., 2015).

Conceptually, Max-Neef's human scale development and Boetto's transformative eco-social models are two approaches that share values and principles of green social work practice. The approaches were adopted to inform social work field education to address FAW infestation in central Malawi (Boetto, 2017; Max-Neef, 1989). The two models argue that to address human-induced climate crises such as pest infestation, there is a need to engage concerned members and a multidisciplinary team in an empathetic dialogue that is devoid of the Western anthropogenic worldview of using synthetic chemicals to control pests. In Malawi, social work theory and practice should shift from green revolution technology anthropogenic worldview to an ecologically centered worldview when addressing socioeconomic challenges that farmers are facing. This call is in line with the need to decolonize social work curricula in Africa by giving room for indigenous knowledge in addressing local problems (Mupedziswa, 2001). Therefore, this research project was intended to engage a social work field education student to attain developmental and green social work knowledge and competencies while working with farmers and multidisciplinary teams to find cost-effective solutions to control FAW pests in maize fields. The student was involved in all stages of the project including forming and coordinating farmers research groups, setting of trial gardens, interpreting research concepts and the rationale for using local pesticides, and writing of the field report.

Materials and methods

Flavonoids and rotenoids tests

Informed by prior studies in Sub-Sahara African countries including Malawi, *Tephrosia vogelii* leaves were collected from the farmers' gardens and were dried in the shade for seven days (Kayange et al., 2019; Li et al., 2015; Ngegba et al., 2022). Then, 300g of the dried *Tephrosia vogelii* leaves were crushed using a pestle and mortar to obtain a fine powder. The maceration method was used to extract flavonoids and rotenoids plant compounds. About 250g of fine powder was mixed with 625ml of ethanol in a stopped container and was allowed to stand at room temperature for 3 days with frequent agitation. After three days, the mixture was then clarified by filtration to obtain the extract where the presence of flavonoids and rotenoids was determined (Mezzomo et al., 2011). An alkaline reagent test was used to test the presence of flavonoids and rotenoids in the leaves. It involved adding three drops of sodium hydroxide to 2ml of the extracts. Initially, a deep yellow color appeared, and it became colorless when drops of dilute hydrochloric acid (HCl) were gradually added which indicated the presence of flavonoids (Manik et al., 2022). For validation purposes, Pew's test was also used separately to test the presence of flavonoids and rotenoids (Rynjah et al., 2018). The protocol included pouring five milliliters of the *Tephrosia vogelii* leaf extract into the test tube. Later 0.1g of metallic zinc and 8ml of concentrated sulfuric acid were added respectively. The reaction of the mixture turned a red color indicating the presence of the flavonoids.

Experimental gardens setup

The study employed a randomized complete block design with four replication gardens (Shieh & Jan, 2004). The four experimental gardens had loam soils and were set up in four adjacent villages in the Dowa district. Each experimental garden in each village was 10 meters away from each other and was enclosed with garden nets to prevent predators from destroying the plants and the armyworms. Each garden was 5m by 5m making it a total of $25m^2$ per garden. In each village, the gardens were labeled W, X, Y, and Z and were assigned as negative control (no pesticides), Belt 480 SC synthetic pesticide treatment, *Tephrosia vogelii* treatment, and Boom detergent soap treatment plots respectively. On 1st December, each plot was planted with 400 hybrid maize seeds. Each seed was planted 25 cm apart and at a depth of 4 cm based on Sasakawa-Global 2000 maize farming recommendation in Malawi (Denning et al., 2009). On the 14^{th} day, when maize had four to five leaves, NPK 23-23-0 fertilizer was applied to the maize gardens using the dollop method at 10 cm deep and 12.5 cm away from the plant (Botoman et al., 2022). When the maize plants were 21 days old, 1600 FAW larvae were equally (400 FAW) introduced to each of the four gardens. The larvae were carefully picked by using forceps from the leave whorls in nearby dry farming maize gardens (dimba) and were kept in open containers for about an hour before infesting the experimental gardens. The first instar larvae (2 days old) were selected to ensure that they remain at the larvae stage during the period of the experiment. In Southern Africa, studies show that FAW larvae take an average of 18 days before turning into a pupa (Kasoma et al., 2022). A FAW larvae was placed on each of the maize foliage in the evening when the average temperature was 24 degrees Celsius which is conducive for the worms (Abdel-Rahman et al., 2023). The FAW location and adaptability were monitored every day and by day five they were actively feeding on maize leaves. By using a 16-liter knapsack sprayer, three gardens (X, Y, Z) of the four gardens (W, X, Y, Z) were treated with Belt 480 SC, *Tephrosia vogelii* crude aqueous leaf extracts, and Boom detergent soap solution respectively. The treatment was conducted when the maize plants were 27 days old and were followed by 8 days of monitoring the number of larvae mortality rates (knockdowns).

Preparation of treatments

1. *Tephrosia vogelii* leaves

Tephrosia vogelii plant leaves were collected from the gardens of farmers that were actively involved in this research project. Informed by other studies (Li et al., 2015), a concentration of 320g/l of *Tephrosia vogelii* leaves was prepared. Then, 320g of *Tephrosia vogelii* leaves were crushed using a pestle and a mortar and 1 litter of water was added to it. The process was repeated to obtain 12.5 liters of the mixture that was required in the $25m^2$ experimental garden. The mixture was then allowed to stand for 48 hours at room temperature. After 48 hours the mixture was filtered by using a sieve to remove the large pieces of leaf material and sprayed immediately using a Knapsack sprayer.

2. Belt 480 SC synthetic pesticide

The instruction on the Belt 480 SC synthetic pesticide was used to inform the preparation of the concentration of the chemical at 0.044ml of Belt 480 SC per liter of water. A 220ml of Belt 480 SC was required to spray a maize field of $10,000m^2$ of land (1 hectare) (Akbar et al., 2018). A total of 0.6ml Belt 480 SC was needed to mix with 12.5 liters of water to spray the experimental garden of $25m^2$. The mixture was sprayed immediately after preparation using a Knapsack sprayer.

3. Boom laundry detergent soap

Boom detergent soap solution was prepared by dissolving 3.75g in 12.5 liters of water 24 hours before spraying into the experimental garden based on a previous study (Matova et al., 2020). Boom is one of the commonly used detergent soaps in Malawi which contains surfactants, sodium carbonate, sodium sulphate, STPP, sodium silicate, enzymes, speckless, sodium alumino silicate, and perfume. Boom soap was claimed to be used by local farmers to control FAW in the study areas.

Data collection

Data were collected in all experimental gardens every day for eight days after spraying the pesticides. Live and dead FAW were traced and located on and around every plant. The FAW knockdown was recorded in a notebook before entry in the Microsoft Excel data spreadsheet.

Data analysis

Analysis of Variance (ANOVA) was used to examine the differences in the efficacy of Belt 480 SC synthetic pesticide, *Tephrosia vogelii* leaves extracts, and Boom detergent soap by using R statistical package. Post-hoc Tukey HSD Test was applied to each of the 6 pairs of experimental data in each village to locate which of the treatments displays the statistically significant difference. Results were set to be statistically significant at a probability of 0.05 (Lee, 2022).

Ethics

This study was part of a biology student research project. Ethics approval was obtained from the University of Malawi Ethics Board (UNIMAREC). Informed consent was obtained from all participating farmers, consented to be part of the farmers' research groups, to provide the project with the local resources needed such as hoes, manure and land (trial gardens).

Results

Phytochemical analysis

The results of *Tephrosia vogelii* phytochemical analysis show that the samples in the two test tubes turned colorless and red when alkaline reagent test and Pew's test were performed respectively. This confirmed that the sampled leaf extracts contained both flavonoids and rotenoids.

Comparison of Belt 480 SC synthetic, Tephrosia vogelii, and Boom detergent soap

The average results of the eight-day FAW knockdown from each experimental garden are shown in Figure 1. There was an average of 90, 84, and 20 FAW knockdowns on day one for Belt 480 SC, *Tephrosia vogelii*, and Boom detergent treatments respectively. All FAW were knocked down on day six in Belt 480 SC treated gardens. In *Tephrosia vogelii* gardens, all FAW were knocked down on day eight. In the Boom detergent soap-treated garden and control garden, 213 (53.3%) and 28(7%) FAW respectively were knocked down on day eight.

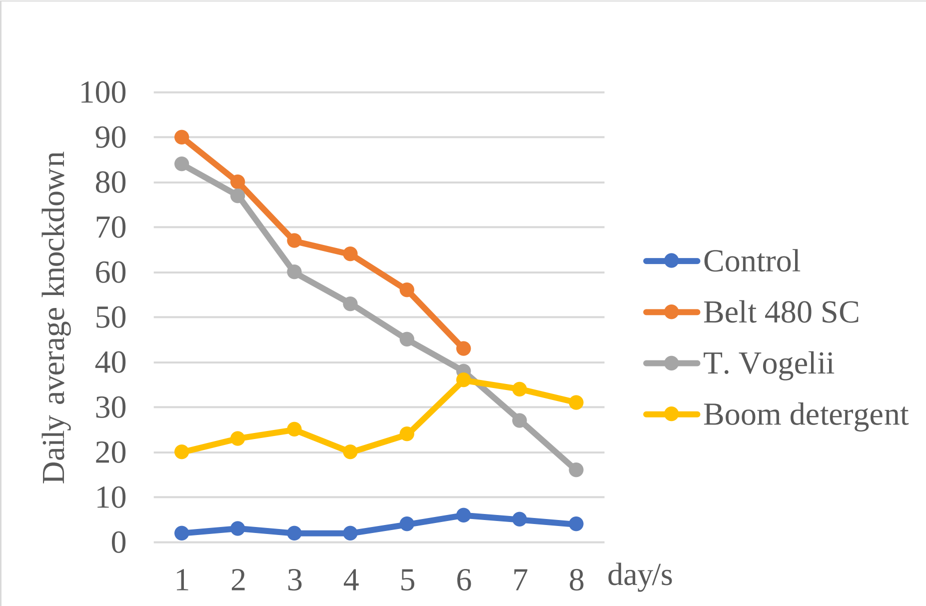

Figure 1: Eight-day FAW knockdown

The results of Tukey HSD multiple comparisons of means show that there was no significant difference in the FAW knockdown between Belt 480 SC and *Tephrosia vogelii* leaves extracts in experimental gardens. On the other hand, the result shows a significant difference in FAW knockdown between Belt 480 SC and Boom detergent soap solution treated gardens. Furthermore, there was also observed a significant difference FAW knockdown between *Tephrosia vogelii* leaf extracts and Boom detergent soap solution experimental gardens. Finally, the results show that all the treated maize gardens had significant difference FAW knockdown compared to control gardens as shown in Table 1.

Table 1: Comparison of effectiveness of pesticides on FAW knockdown in maize fields

Treatments pair	**Tukey HSD Q statistic**	**Tukey HSD p-value**	**Tukey HSD inference**
Control V Belt 480 SC	11.3324	0.0010053	** p<0.01
Control V *Tephrosia Vogelii*	9.0107	0.0010053	** p<0.01
Control V Boom detergent	4.4812	0.0191207	* p<0.05
Belt 480 SC V *Tephrosia Vogelii*	2.9901	0.1750727	insignificant
Belt 480 SC V Boom detergent	7.1837	0.0010053	** p<0.01
Tephrosia Vogelii V Boom	4.5296	0.0176450	* p<0.05

Discussion

FAW outbreaks are causing significant maize damage in Sub Saharan-African countries including Malawi. Farmers are seeking cost-effective methods of controlling FAW pests (Kosamu et al., 2020). *Tephrosia vogelii* leaf extracts are potential botanical candidates for controlling FAW with limited impacts on the environment. This study found that *Tephrosia vogeli*i leaves contained flavonoids and rotenoids that have pesticidal properties. The finding supports a previous study in central Malawi that validated *Tephrosia vogelii* leaves in the central Malawi agroecological zone contains flavonoids and rotenoids chemotypes (Belmain et al., 2012).

The results of this study suggest that despite the Belt 480 SC synthetic pesticide and *Tephrosia vogelii* leaf extracts having similar FAW knockdown potency, the former kills the pests at a faster rate than the latter. Belt 480 SC destroyed all the pests in six days while *Tephrosia vogelii* leaf extracts destroyed all the FAW in eight days. The findings agree with other studies in Sub Saharan-Africa that show botanical pesticides such as *Tephrosia vogelii* leaf extracts are efficient in destroying pests, but their actions are slower compared to synthetic pesticides (Ngegba et al., 2022).

The results further show that despite the Boom detergent soap solution being able to destroy about half of the FAW in eight days, it was significantly less potent than *Tephrosia vogelii* leaf extracts. This findings correspond with a study in Ghana that showed Alata Samina local soap solution was ineffective in controlling FAW compared to biochemicals (Babendreier et al., 2020). It is important to note that Boom detergent is a laundry soap which is not meant to be used as a pesticide. Therefore, social and extension workers need to discuss with farmers that Boom detergent soap solution is not as effective as *Tephrosia vogelii* extracts in controlling FAW in the study areas.

Finally, our study indicates that the application of Belt 480 SC, *Tephrosia vogelii* leaves extracts, and Boom detergent soap solution was significantly effective in knocking down FAW pests compared to non-treated (control) gardens. The findings agree with a cost-effective study that was conducted in Benin which shows that soap solution, biochemicals, and synthetic pesticides were more effective in controlling FAW compared to untreated gardens (Aniwanou et al., 2020).

Implication for social work field education

Our study has significant implications for social work field education in the rural setting of Malawi where communities are experiencing household food insecurity due to climate-induced FAW pest outbreaks. First, the study has illustrated that a multidisciplinary crop protection research-based social work field work can provide a context where students can learn and practice developmental and green social work in real-life situations. Hence, such field education can address the concerns that social work education in Africa has limited environmental and development contents that minimize social workers' engagement with communities that are affected by climate change (Arkert & Jacobs, 2023). In this research project, a social work educator assigned a social work field education student to an agency that aims at addressing FAW crisis in the maize fields of rural smallholder farmers. This was an opportunity for the student to gain a deeper understanding of social work's commitment to a person-in-environment perspective (Miller & Hayward, 2014). In this agency, the student worked in a multidisciplinary team that included natural and social scientists. The social work practicum student's main role was to coordinate the project. Among others, the student was exposed to an inclusive development-focused learning environment that integrates and empowers farmers to use environmentally-friendly indigenous resources to mitigate FAW infestation in crop fields. In the process of coordinating the project, the student gained advocacy skills that are required in the social work profession.

Secondly, this study has demonstrated that when a field education student is engaged in developmental and green social work with underprivileged farmers, there are also opportunities to apply and promote core social work values and principles. Respect for the inherent dignity and worth of persons with a focus on client self-determination was one of the social work values that the student was able to foster (Kirzner & Miserandino, 2023). In this study, despite the practicum student's awareness of numerous challenges facing farmers such as domestic violence, child undernutrition, and high malaria incidence, farmers prioritized mitigation of FAW in their maize fields (Chilanga et al., 2020a; Chilanga et al., 2020b; Chilanga & Chilanga, 2023). In this case, the FAW experiments were initiated based on the needs of the local people that ensured that the student adhered to the social work principle of self-destiny. Future research and social work practice interventions are needed to address domestic violence and the high malaria incidence rates among farmers.

Limitations

Literature shows that the concentration of flavonoids and rotenoids in *Tephrosia vogelii* leaves varies depending on season and geographical location (Belmain et al., 2012). This study was conducted during the 2022/2023 rainy season in central Malawi when *Tephrosia vogelii* leaves were dark green. Therefore, the interpretation of these findings should consider the experimental season as there are chances that different results may be obtained in the dry season. We suggest that more rigorous studies should be conducted across the seasons in the study area to determine the consistency of our current study.

The study did not compare the toxicity level of *Tephrosia vogelii* leaf extracts to Belt 480 SC pesticide. This study component could be necessary as it could establish the degree of toxicity of biochemicals in *Tephrosia vogelii* extracts to ensure that its application does not pose bioaccumulation threats in food chains (Tongo et al., 2022). In our next research project, we will engage toxicologists in Malawi to compare the toxicity of *Tephrosia vogelii* extracts and other chemicals that are used to control FAW.

Conclusion

In Malawi, FAW infestation in maize crops is of great concern to small-scale farmers, social workers, and policymakers as it drastically reduces maize yields and exacerbates household food insecurity. Despite the widespread use of synthetic chemical pesticides, FAW infestation in maize fields is still on the rise in Malawi. *Tephrosia vogelii* leaves contain bioactive phytocompounds that have pesticidal properties. Research indicates that geographical location and plant species influence the occurrence of pesticidal bioactive phytocompounds in *Tephrosia vogelii*. Even though farmers in Sub-Saharan Africa are using *Tephrosia vogelii* as a pesticide, there are mixed research findings regarding its effectiveness in controlling FAW in maize crops. This study was informed by developmental and green social work frameworks to examine the presence of flavonoids and rotenoids, and their effectiveness in controlling FAW in maize trial gardens. Laboratory and field experiments were performed by a multidisciplinary team of experts from November 2022 to March 2023. The study affirmed that *Tephrosia vogelii* leaf extracts from selected gardens in Dowa District central Malawi contain flavonoids and rotenoids. The finding rationalized the research team to carry out the experiments. The results of field gardens suggest that *Tephrosia vogelii* leaf extracts have similar potency to Belt SC 480 chemical pesticides in controlling FAW pests. One critical insight of our study is that Belt SC 480 chemical takes six days while *Tephrosia vogelii* leaf extracts takes eight days to completely destroy the pests. It has been identified that the Boom detergent soap that farmers are using in the area is not as effective as *Tephrosia vogelii* leaf extracts in controlling FAW infestation. We suggest that farmers should be discouraged from using Boom soap as its main purpose is for laundry. Our study had developmental and green social work field education implications that include field education student gaining community mobilization skillsets, environmental justice, and social work values. These social work competencies are indispensable in agrarian communities of Malawi.

Declaration of conflicting interest

We declare no competing interests.

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