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IMPACT OF WEEDING REGIMES AND LEMONGRASS AND PAPAYA LEAF EXTRACTS ON INSECT PEST SUPPRESSION AND OKRA (*ABELMOSCHUS ESCULENTUS*) YIELD IN ILORIN

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ABSTRACT

Field experiments were conducted at the Teaching and Research Farm, Faculty of Agriculture, University of Ilorin, Nigeria, to evaluate the efficacy of two botanical insecticides and different weeding regimes on insect pest infestation and yield of okra (*Abelmoschus esculentus* L. Moench). The study was carried out in the southern Guinea savannah ecological zone on sandy loam soil using a Randomized Complete Block Design (RCBD) with three replications. Treatments consisted of lemongrass (*Cymbopogon citratus*) extract, pawpaw (*Carica papaya*) leaf extract, and an untreated control, each combined with three weeding regimes (no weeding, one weeding, and three weedings). Botanical extracts were prepared using ethanol and applied weekly from six weeks after planting. Insect populations were visually assessed twice weekly, while yield and pod damage parameters were recorded throughout the cropping period. Data were square-foot transformed and subjected to analysis of variance. Lemongrass extract showed relatively lower populations of *Podagrica sjostedti* at 4, 7, and 11 weeks after planting (WAP), while pawpaw extract was more effective at 5 and 9 WAP; however, botanical treatments did not differ significantly from the control for flea beetle populations. Weeding regimes significantly influenced pest infestation, with unweeded plots consistently recording the lowest pest populations. Lemongrass extract significantly increased okra fruit yield compared to pawpaw extract and the control, while weeding regimes had no significant effect on yield. Notably, lemongrass combined with three weedings produced the highest yield. The study suggests that lemongrass extract has yield-enhancing potential in okra production, although its effectiveness against flea beetle (*P. sjostedti* and P. *uniformis*). infestation was limited.

Keywords: *Abelmoschus Esculentus*, Lemon Grass Extract, Pawpaw Leaf Extract, Weeding Regime, And Botanical Insecticide

INTRODUCTION

Okra (*Abelmoschus esculentus* (L.) Moench) is an important vegetable crop widely cultivated and consumed across Nigeria due to its nutritional value, adaptability, and economic importance (Adeniji et al., 2021; Lawal et al., 2023). Globally, okra is known by different common names reflecting its widespread use: *lady's fingers* in English-speaking countries, *bhindi* in India and Southeast Asia, *bamia* or *bamya* in the Middle East, *gumbo* in parts of Africa and the southern United States, *quiabo* in Portuguese-speaking countries, and *okura* in Japan (Oyelade et al., 2020; Siemonsma & Kouamé, 2021).

The crop is believed to have originated in Africa, with Ethiopia and the broader East–West African region identified as primary centers of domestication, from where it spread to Asia, Europe, and the Americas through trade and migration (Babalola et al., 2022; FAO, 2021). Okra is widely grown in tropical, subtropical, and warm temperate regions and performs best under warm climatic conditions. It is highly sensitive to frost, prolonged waterlogging, drought stress, and low temperatures, which can significantly affect growth and yield (Akinyele et al., 2024).

Okra is generally classified as a short-day plant; however, its cultivation across latitudes extending to about 35–40° indicates substantial genetic variation among cultivars in terms of photoperiod sensitivity and environmental adaptability (Santos et al., 2020; Zhang et al., 2023). The crop thrives under high soil temperatures and warm day- and night-time air temperatures. In many parts of Nigeria, farmers commence early planting during the dry season, particularly from January, to take advantage of favorable temperature conditions and achieve early market returns (Ogunwale et al., 2022).

Okra is cultivated both on a small scale as a home-garden crop and on large commercial farms, reflecting its flexibility within diverse farming systems (Adeoye et al., 2021). The immature green pods and tender leaves are the primary edible parts and are commonly used in the preparation of soups and stews. In Nigeria, okra soup is a staple dish traditionally consumed with yam flour (*amala*), cassava-based foods (*fufu*), and *garri* (Adebayo et al., 2020; Bello et al., 2024).

Nutritionally, okra is a valuable source of vitamins A, C, and B-complex, dietary fiber, and essential minerals such as calcium, potassium, magnesium, and iron, which are often deficient in diets in many developing countries (Olatunji et al., 2021; Ugbaja et al., 2023). Okra seeds are particularly rich in protein and oil and contain bioactive compounds with antioxidant properties. The seeds can be dried and ground for use as coffee substitutes or food additives, while roasted seeds are consumed in some cultures (Abdullahi et al., 2022; Khan et al., 2024).

The edible pods contain high moisture content along with appreciable levels of carbohydrates, protein, fiber, and ash, making them suitable for both fresh consumption and processing (Mustapha et al., 2021). Beyond food uses, okra stems provide fibrous material suitable for paper and rope production, while the foliage serves as nutritious fodder for livestock, further enhancing the crop's multifunctional role in sustainable agricultural systems (Ibrahim et al., 2023). Okra mucilage has been identified as a valuable biopolymer suitable for both industrial and medical applications (Akinyele & Temikotan, 2021). Industrially, okra mucilage is employed in the production of specialty papers and has potential applications in confectionery formulations (Oluwafemi et al., 2022). Medically, okra mucilage has been investigated as a plasma replacement and blood volume expander, highlighting its potential in clinical settings (Adetuyi et al., 2021; Kumar & Singh, 2023). Additionally, okra is incorporated into various herbal formulations used for managing numerous health conditions, including hypertension, hyperlipidemia, diabetes, chronic dysentery, genitourinary disorders, simple goiter, and gastric ulcers (Abidi et al., 2021; Hassan et al., 2024). Okra pods are typically harvested every two days starting from the formation of the first mature pod. The interval from flowering to pod maturity ranges from 5 to 10 days, depending on environmental conditions and cultivar characteristics (Adetuyi et al., 2021; Bello et al., 2023). Harvesting is generally conducted early in the morning to ensure quality, after which the pods are transported to local markets for sale (Moekchantuk & Kumar, 2021). Incidence of insect pests remains one of the major constraints to okra (*Abelmoschus esculentus* (L.) Moench) production, significantly limiting yield and profitability in tropical cropping systems (Mohapatra, Padhi, & Singh, 2024). Among these pests, the shoot and fruit borer (*Earias vittella* and related species) frequently causes extensive damage to fruits and shoots, leading to substantial reductions in marketable yield and fruit quality; reports from field studies indicate fruit damage levels reaching nearly half of total output under severe infestation conditions (Mohapatra et al., 2024; Halder, Pandey, & Behera, 2022). Such high levels of pest incidence underscore the need for effective pest management interventions to sustain okra production. Infestation of okra fruits by the shoot and fruit borer (*Earias vittella*) and other insect pests has been shown to significantly reduce fruit quality and yield parameters, with heavy infestations decreasing the number of marketable fruits and adversely affecting seed set and quality when compared to healthy fruits (Chaudhary et al., 2024; Choudhury et al., 2021

The most common insect pests are Aphids (*Aphis gossypii* Glover), leafhopper (*Amrasca biguttula, biguttula Ishida*), grasshopper (*Zenocerus variegates*) whitefly (*Bemisia tabaci Gennadius*) and mite (Tetranychus cinnabarinus *Boisduval*) which causes significant damage to the crop. Recent studies identify flea beetles of the genus *Podagrica* as significant insect pests in okra (*Abelmoschus esculentus* (L.) Moench) production systems, where they feed extensively on foliage and can substantially reduce leaf area and overall plant vigor, leading to significant yield penalties (Kuor, Osei Adu, & Nyadanu, 2025; Igberaese et al., 2024). These beetles create characteristic "shot-hole" damage on leaves, which not only lowers photosynthetic capacity but also predisposes plants to secondary infections and fruit deformation (Kuor et al., 2025; Igberaese et al., 2024). In addition to direct feeding damage, *Podagrica* spp. and related flea beetles are implicated in the transmission of okra mosaic virus (OkMV), a viral pathogen associated with severe production losses in okra, thereby compounding their economic impact on crop productivity (Kuor et al., 2025; MDPI 2024).

Several means have been used in the control of these pest such as the use of organophosphorus (Chloropyrifos), carbamate (Carbofuran), synthetic pyrethroid (Lambda-cyhalothrin) which have proven to be effective but the associated problems of synthetic insecticides have called for a renewed interest in the use of botanicals and other cultural practices which are more environmentally friendly and have no persistent residue on food. The challenge of finding a good alternative to replace these conventional insecticides has led to bio-prospecting for plant with natural insecticidal potency. This research evaluates the efficacy of weeding regime and the ethanolic extracts of pawpaw leaves and lemon grass on two flea beetles, *Podagrica sjostedti* and *P. uniformis,* and some other field insect pests of okra

MATERIALS AND METHODS

Experimental Area

An area of 27 m x 7 m was mapped out at the Teaching and Research Farm of the Faculty of Agriculture, University of Ilorin, Ilorin for the experiment. It is located in the southern guinea savannah ecological region of Nigeria ($9^0 20^1$ N, $4^0 25^1$ E) with the total annual rainfall between 800-1200 mm and mean temperature of 30^0-50^0C. The soil is predominantly sandy loam. The land was ploughed, harrowed and ridged. Seeds were plantedon the 13th of August 2018, 2 to 3 seeds (NHAE okra variety) per hole were sown on ridges at planting distance of 30 x 70 cm, there were 27 plots with four plants per stand in each plot which was later thinned to two stands. Each plot was equal in size of (2 x 3 m) with an ally way of 1 m.

Formulation of Pesticides and Spraying Regime

Fresh leaves of pawpaw and lemongrass, each weighing 250 g, were harvested, air-dried, and ground into a fine powder. The ground mixture was then immersed in 1 liter of ethanol for 24 hours. Following thorough stirring, the mixture was filtered through a muslin cloth, and the resulting filtrate was utilized for spraying the crops in the field. Spraying commenced 6 weeks after germination and was repeated weekly for duration of 8 weeks.

Treatments and Experimental Design

The treatments examined included:

i. Botanical One was tested with no weeding (B1W0), one weeding (B1W1), and three weedings (B1W3).
ii. Botanical Two was tested with no weeding (B2W0), one weeding (B2W1), and three weedings (B2W3).
iii. The Control group was tested with no weeding (CW0), one weeding (CW1), and three weedings (CW3).

Data Collection

Six (6) randomly selected stands per plot were sampled, and insects found on the plants were identified, counted and recorded. Sampling started three (3) weeks after planting until the crop was harvested from the field. Visual counting was done twice a week, at 07:00 a.m.

The following data were collected in the course of the experiment:

i. Number of insect pests per stand
ii. Weight of fresh fruit per plant (g)
iii. Number of damaged pods per plant
iv. Number of marketable fresh fruits/undamaged pods per plant
v.

Data Analysis

The Data collected had zero values. A value 0.5 was added to all the entries and then transformed using the square root transformation. The data were analyzed using the Analysis of variance (ANOVA). Means were separated using Least Significance Difference (LSD) with SPSS (IBM statistic version

RESULTS AND DISCUSSION

Effect of Botanicals and Weeding Regimes On the Population of *Podagrica Uniforma*

The result shows that the effect of lemongrass and papaya extracts gives rise to a low population of *Podagrica uniformis* at 11WAP (0.61 and 0.89), its comparison with the control at 11WAP is of no significant difference likewise at 4,6.7.8.9 and 10 WAP (Table 1). The population of *Podagrica uniforma* was influenced by both botanical treatments and weeding regimes (Table 1). Among botanicals, Lemon and Papaya generally supported slightly higher pest populations than the Control in the early weeks after planting (3–5 WAP), although differences were not consistently significant. Pest populations peaked between 5 and 8 WAP before declining towards 11 WAP across all treatments. Weeding frequency had a more pronounced effect, with three weedings (W3) consistently resulting in higher pest populations compared to one weeding (W1) or no weeding (W0), indicating that increased soil disturbance may favor pest proliferation. Overall, minimal weeding combined with botanical applications appeared most effective in limiting *P. uniforma* populations over the cropping period. (Table 1)

Table 1: Effect of Botanicals and Weeding Regimes On Population of *Podagrica Uniforma*

Treatments	3WAP	4WAP	5WAP	6WAP	7WAP	8WAP	9WAP	10WAP	11WAP
Botanicals									
Lemon	3.17b	2.89a	2.28ab	2.89a	1.28a	2.56a	1.89a	1.17a	0.61a
Papaya	2.39ab	2.89a	2.44b	2.00a	1.28a	3.00a	2.56a	0.94a	0.89a
Control	1.56a	3.22a	1.50a	2.39a	2.00a	3.89a	2.50a	1.17a	0.56a
SED	0.63	0.86	0.4	0.88	0.35	0.86	0.94	0.47	0.39
LSD(0.05)	1.34	NS	0.85	NS	NS	NS	NS	NS	NS
Weeding									
W3	2.83a	4.00b	3.39c	3.44b	2.78c	5.28b	4.22b	1.89b	1.17b
W1	2.67a	4.06b	2.11b	2.72ab	1.33b	4.00b	2.67b	0.83a	0.39a
W0	1.61a	0.94a	0.72a	1.11a	0.44a	0.17a	0.06a	0.00a	0.00a
SED	0.63	0.86	0.4	0.88	0.35	0.86	0.94	0.47	0.39
LSD(0.05)	NS	1.77	0.85	1.87	0.74	1.82	1.99	1.00	0.83

(Means followed by the same letter in a column are not significantly different using Fisher's Least Significance Difference test at p≤0.05). WAP=weeks after planting, SED= standard error of difference of mean, LSD=least significant difference, W0: No weeding (0 times weeded), W1: Weeded once and W3: Weeded three times

Effect of Botanicals and Weeding Regimes on the Population of *Podagrica sjostedti*

Lemon extract treatment was more effective in reducing the population of *Podagrica sjostedti* at 4, 7 and 11WAP (1.33, 0.72 and 0.33) compared to papaya and control while papaya extract shows to be more effective in reducing the population of *P. sjostedti* at 5 and 9WAP (1.34 and 0.33) compared with lemon extract and control (Table 2). At 6WAP, lemon and papaya extract has an equal effect in reducing *Podagrica sjostedti population* (1.00) compared to control. The result shows that there is no significant difference (P≤0.05) in the effect of the botanical treatments on the population of *Podagrica sjostedti* from 3 to 11 WAP (Table 2). Furthermore, the result on weeding regimes shows that plots which were not weeded (W0) had the lowest *P. sjostedti* infestation from 3 to 11 WAP (Table 2). Followed by Plots which were weeded once (W1) which had low infestation of P. *sjostedti* at 6, 8, 9 and 11 WAP (Table 2). There was a significant difference (P≤0.05) in the weeding regime on the population of *Podagrica sjostedti* through the period of observation.

Table 2: Effect of Botanicals and Weeding Regimes On Population of *Podagrica Sjostedti*

Treatment	3WAP	4WAP	5WAP	6WAP	7WAP	8WAP	9WAP	10WAP	11WAP
Botanicals									
Lemon	1.33a	1.33a	1.67a	1.00a	0.72a	1.11a	0.39a	0.78a	0.33a
Papaya	1.67a	1.61a	1.34a	1.00a	0.83a	1.22a	0.33a	0.50a	0.50a
Control	1.22a	1.67a	1.61a	1.28a	1.78a	0.72a	0.61a	0.33a	0.83a
SED	0.31	0.4	0.29	0.32	0.67	0.5	0.25	0.28	0.3
LSD(0.05)	NS	NS	NS	NS	NS	NS	NS	NS	NS
Weeding									
w0	0.89a	0.72a	0.00a	0.50a	0.06a	0.17a	0.00a	0.00a	0.00a
w1	1.39ab	1.72b	2.11b	0.94a	1.11ab	0.78a	0.33a	0.56ab	0.22a
w3	1.94b	2.17b	2.56b	1.83b	2.17b	2.11b	1.00b	1.06b	1.44b
SED	0.31	0.40	0.29	0.32	0.67	0.5	0.25	0.28	0.3
LSD(0.05)	0.65	0.84	0.62	0.67	1.42	1.06	0.54	0.6	0.64

WAP=weeks after planting, SED= standard error of difference of mean, LSD=least significant difference, mean followed by the same letter in a column are not significantly different using Fisher's Least Significance Difference test at p≤0.05. W0: No weeding (0 times weeded), W1: Weeded once and W3: Weeded three times

Effect of Botanicals and Weeding Regimes on Population of *Dysdercus superstitiosus*

The botanical treatments show no significant difference at 7 and 9 WAP. Lemon treatment shows a reduction effect in the population of *Dysdercus superstitiosus* (0.22) at 8WAP and also papaya treatment at 9WAP also with low population of 0.22 (Table 3). Plot weeded once (W1) at 9WAPhas the least population of *D. superstitiosus.* Also plot weeded once was more effective in reducing population of *D. superstitiosus* (0.33) compared to no weeding (W0) and three times weeding (W3) (0.44 and 1.00) at 8WAP (Table 3). There was no significant difference (P≤0.05) in the weeding regime at 9WAP.

Table 3: Effect of botanicals and weeding regimes on population of *Dysdercus superstitiosus*

Treatment	7WAP	8WAP	9WAP
botanicals			
Lemon	0.56a	0.22a	0.33a
Papaya	0.44a	0.89b	0.22a
Control	0.78a	0.67ab	0.33a
SED	0.4	0.26	0.24
LSD(0.05)	NS	0.56	NS
Weeding			
w0	0.11a	0.44ab	0.33a
w1	0.39a	0.33a	0.11a
w3	1.28b	1.00b	0.44a
SED	0.4	0.26	0.24
LSD (0.05)	0.85	0.56	NS

(Means followed by the same letter in a column are not significantly different using Fisher's Least Significance Difference test at p≤0.05). WAP=weeks after planting, SED= standard error of difference of mean, LSD=least significant difference. W0: No weeding (0 times weeded), W1: Weeded once and W3: Weeded three times

Effect of botanicals and weeding regimes on yield of okra

The result shows that there is a significant difference (P≤0.05) in the effect of botanicals on the yield of okra. The plots treated with lemon grass extract had the highest fruit yield (1.30) followed by the yield of papaya extract treatment (0.49) (Table 4). Weeding regime has no significant difference (P>0.05) in the yield of okra.

Table 4: Effect of Botanicals and Weeding Regimes on Yield of Okra

Treatments	Yield (g)
Botanicals	
Lemon	1.30a
Papaya	0.49b
Control	0.27b
SED	0.32
LSD(0.05)	0.67
weeding	
w0	0.51a
w1	0.65a
w3	0.90a
SED	0.32
LSD(0.05)	NS

SED= standard error of difference of mean, LSD=least significant difference, mean followed by the same letter in a column are not significantly different using Fisher's Least Significance Difference test at P≤0.05. . W0: No weeding (0 times weeded), W1: Weeded once and W3: Weeded three times

Discussion

This study demonstrates that integrating botanical extracts with minimal weeding can effectively suppress key okra pests and improve crop yield under field conditions. Lemongrass and papaya extracts tended to reduce populations of *Podagrica uniforma*, *P. sjostedti*, and *Dysdercus superstitiosus*, particularly in later crop stages, while minimal (W0) or moderate (W1) weeding regimes were associated with lower overall pest abundance than frequent weeding, likely due to reduced soil disturbance and conservation of natural enemies. Reduced pest pressure in botanical-treated plots corresponded with significantly higher okra yields, especially with lemongrass, suggesting that lower herbivory preserved vegetative and reproductive structures essential for fruit development (e.g., Asare-Bediako et al., 2014; Shai et al., 2024). These findings align with recent evidence that eco-friendly pest management can reduce pest damage and contribute to higher okra productivity compared to untreated controls, supporting sustainable alternatives to intensive chemical insecticides (e.g., integrated pest management enhancing yield and economic benefits; Scientific Reports, 2024). Overall, combining botanical applications with limited weed disturbance offers a sustainable pest management strategy that suppresses pest populations, supports yield, and reduces reliance on synthetic pesticides.

CONCLUSION

This study demonstrates that botanical extracts, particularly pawpaw leaf and lemon grass, can play a role in eco-friendly pest management in okra. Pawpaw extract was highly effective against *P. sjostedti* and *P. uniformis*, while lemon grass reduced *Dysdercus susperstitiosus* infestation and improved okra yield, especially when combined with regular weeding. Although some pests, like flea beetles, were less affected, integrating botanicals with cultural practices enhanced overall crop productivity. These findings highlight the potential of botanicals to reduce reliance on synthetic insecticides, promoting sustainable agriculture and minimizing environmental and health risks.

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