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Original Article

Flea beetle infestation and control strategies as perceived by farmers of Malvaceae crops in Benue State, Nigeria

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ABSTRACT

Flea beetles, *Podagrica* spp. (Coleoptera: Chrysomelidae) have been reported as insect herbivores associated with crops in the Malvaceae (mallow) family. But information on their infestation levels and control strategies employed in many production areas of Nigeria are still scanty. A multi-stage random sampling procedure was used to select 120 Malvaceae crop (okra, roselle, kenaf, and cotton) farmers in Benue State, Nigeria. A structured interview schedule was used to elicit information on their socio-economic characteristics; insect infestation/damage levels and flea beetle control tactics employed by the farmers. Results showed that all the farmers (100%) identified flea beetle infestation as the most important constraint in Malvaceae crop production. About 55.8% considered the damage as very severe; 42.5% viewed it as severe, while 1.7% reported mild levels of crop damage. About 85.8% do nothing to control the pest, 84.2% use foliar application of wood ash, 60.0% use synthetic chemicals, and 60.8% use other measures. The association between the socio-economic variables (age, marital status, education, occupation, and years of farming experience) and the beetle control strategies (e.g., cropping systems, botanicals, doing nothing, wood ash, and synthetic insecticides) was significant (P <0.05). But handpicking of the beetles was not significantly (P >0.05) correlated with the farmers' socio-economic characteristics. We conclude that *Podagrica* spp. are destructive pests of crops in the Malvaceae family. However, the improvement of farmers' socio-economic status, provision of pest control inputs, and training of farmers through extension efforts could significantly boost the production of the crops in the study area.

Keywords: Crop damage, insect infestation, Malvaceae crop, pest control, *Podagrica* spp.

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INTRODUCTION

The family Malvaceae (mallows) consists of a major plant group called the Angiosperms (Flowering plants). They are made up of herbs, shrubs, or trees from about 244 genera with about 4225 known species.[1] Cotton, kenaf, jute mallow, okra, roselle, baobab, cacao, and kola are some of the important mallows cultivated in Nigeria. These crops have been widely used for fiber, food, beverages, vegetable oils, timber, medicine, horticulture, etc.[2] They also contribute a key role in income generation and poverty alleviation for the teeming population of many African countries.[3]

Insect pests have been reported as one of the major productivity limiting factors in most Malvaceae crop fields.[4-6] In Nigeria, *Podagrica uniforma* Jacoby and *Podagrica sjostedti* (Jacoby) have been identified as the two most important specialized herbivores associated with these Mallows.[6-8] The adults feed on the leaf laminae by making numerous holes on the leaves which subsequently result in the reduction of assimilative tissues leading to a significant loss in crop yield.[5,7] The larvae are also reported to feed on rootlets in the soil leading to plant death at the seedling stage.[9] On hosts like okra, the flea beetle population could be as much as 90% of the total insect population encountered during the vegetative growth stage.[10] The beetles are also reported to vector the virus that causes okra mosaic disease.[11,12]

Lots of research efforts have been carried out to arrive at a lead for effective management of flea beetles in Malvaceae crop field. Pest management recommendations involving the use of biopesticides such as *Azadirachta indica* A. Juss., *Monodora*

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myristica Gaertn., *Jatropha curcas* Linn., *Vernonia amygdalina* Del., *Annona squamosa* Linn., and other plant extracts have been suggested.[13-16] Intercropping Malvaceae crops with either tomato, cowpea, or groundnut were also reported to be effective against the beetles.[17,18] But poverty, inadequate access to research findings, lack of training, limited access to funds, etc., are among the major hindrances to the adoption of these measures by farmers.[19,20] As a result, most farmers neglect the damage caused by the insects and consume or sell whatever is left of the produce. This pitiable practice amounts to gross waste and significant yield reductions annually. Most times, the farmers are not even aware of the extent of the loss incurred as a result of flea beetle infestation of their farms.

At present, there is a demand-driven increase in the production of okra, roselle, jute mallow, etc., and cotton among small smallholder farmers who are the major production stakeholders in the Nigerian agricultural sector.[21,22] It is, therefore, imperative to identify factors that affect the production of these crops so as to proper solutions that could boost production and sustain their supply. This study was therefore undertaken to document farmers' perception of the pest problems associated with Malvaceae crops, the severity of *P. uniforma* and *P. sjostedti* attacks in Malvaceae crop fields, and to ascertain the pest management practices adopted for control of the pests in farmers' fields at Benue State, Nigeria. This information could be helpful when planning a sustainable pest management program for *P. uniforma* and *P. sjostedti* in Malvaceae crops fields in Nigeria.

MATERIALS AND METHODS

The Study Area

The study was carried out at Benue State (BN), Nigeria (NG) (coordinates: Longitude 7° 47' and 10° 0' E. Latitude 6° 25' and 8° 8' N). Geographically, BN lies within the Southern Guinea Savanna agro-ecological zone of Nigeria and shares boundaries with Nasarawa State to the north, Cross-River State to the south, Enugu State to the south-west, Taraba State to the east, and Kogi State to the west [Figure 1]. Agriculture is the main economic activity employing an estimated 413,159 farm families in the state.[23,24] The State also has vast fertile land with the capacity to produce virtually all major food crops cultivated in Nigeria.[24]

Study Population, Sample, and Sampling Procedure

The target population for the study consisted of Benue farmers who have been cultivating Malvaceae crops such as okra, kenaf, roselle, jute mallow, and cotton. A multistage random sampling technique involving four random selection stages was used to select the sample size for the study: Stage 1 involves the selection of the three existing Agricultural Development Programme (ADP) zones (A, B, and C) [Figure 1]. In stage 2, two agricultural blocks were randomly selected from each of the ADP zones to give a total of 12 (6) blocks. The selected blocks are Logo and Vandeikya from zone A; Buruku and Makurdi from zone B; while Apa and Oju blocks were randomly selected from zone C. The third stage 3 involves the random selection of two ADP circles from each of the selected blocks making a total of 12 circles. The selected circles are Mbagam and Nenzegh from the Logo block; Mbadede and Bagbam from the Vandeikya block; for the Buruku block, it was Binev and Mbapen; Makurdi block was Northbank and Nyien; and Ugbokpo and Oiji were selected from Apa block; while Adenu and Owo circles were selected from Oju block. Stage 4 involves the selection of ten (10) Malvaceae crop farmers from each circle to give a total sample size of 120 farmers.

Research Instrument

A structured interview schedule for farmers was designed to elicit information on socio-economic characteristics of the farmers; Malvaceae crop production characteristics, insect infestation/damage levels, pest control options used by the farmers, and yield. Three field assistants (graduates in the field of agriculture science, having good communication skills in the major local languages in the state) were trained to support the process. A pictorial guide for each section of the research instrument was also developed to enhance communication with the farmers.

Indices, Scales, and Hypotheses Tested

Suitable weights were assigned to the indicators used to ascertain the influence of socio-economic factors (age, marital status education, occupation, farm size, etc.) on farmers' choice of control measures used against flea beetles. This was done in consultations with experts including statisticians. The crop damage severity ratings used were: very severe ≥70% of crops in farmers' plots were damaged; severe = 50–69% crop damage; moderate = 20–49% damage; mild = 1–19% of crops were damaged, and none = No plant was damaged by the particular insects. The percentage occurrence of damage (POD) = % of farmers who observed cases of insect damage in their fields. The null hypothesis tested in the study states that there were no significant differences between the socio-economic characteristics of the farmers and their choice of flea beetle control strategy.

Statistical Analysis

Data collected were analyzed using both descriptive (means, frequency distribution, and percentages) and inferential statistics (correlation analysis).[25]

RESULTS

Socio-economic Characteristics of Farmers who Participated in the Study

The majority of the Malvaceae crop farmers sampled were male 78 (65%) [Table 1]. Farmers within 41–50 years of age

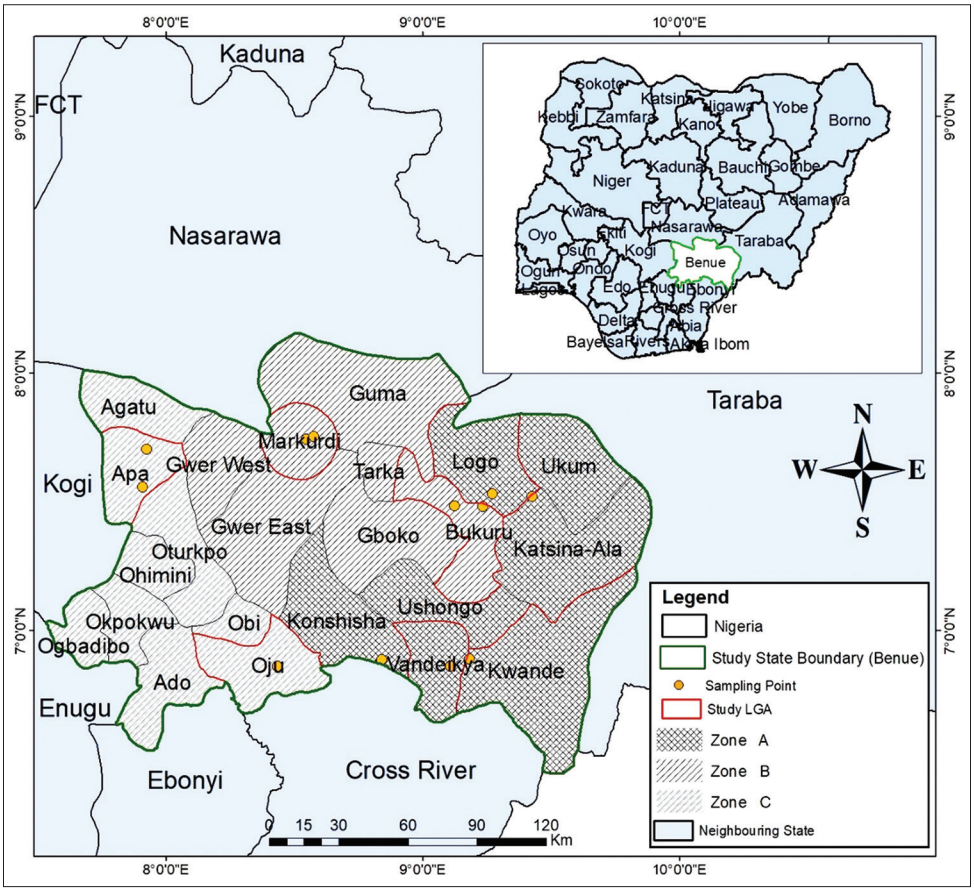

Figure 1: Map of Benue State showing the sampled areas

were the highest (40.8%) in number in the study area, followed by farmers that were 31–40 years of age and they constituted 32.5% of the total population, farmers above 50 years of age were about 19.2% of the population. Only one farmer (0.8%) was below 20 years of age. Most of the farmers were married (92.5%), while the singles, widows, and those separated from their spouses were 4.1% of the population.

The Tiv tribe constituted 65.8% of the farmers interviewed, while the Idomas and the Igedes made up 33.4% (16.7%) each, and only one farmer (0.8%) was from the Hausa tribe. The result also showed that 26.7% of the farmers had no formal education. Whereas 38.3% had the primary/adult form of education; 30% of the farmers had secondary education and only 5% had tertiary education. About 84.2% of the respondents were engaged in farming as their major/primary occupation, while 13.3% were civil servants, 1.7% were traders and only one of the crop farmers (0.8%) was primarily an artisan. However, the secondary occupation that most of the farmers were engaged in was trading (40%), followed by farming (15.8%), the artisans were 2.5%, and other secondary occupations such as hunting and local security services constituted 6.7%. About 35% of the farmers had no secondary occupation. Most of the farmlands in the study area were acquired by inheritance (71.7%), while about 5.8% of the farmers purchased their farmland and 8.3% were granted use of the land over a specific period usually at no monetary cost (rent). But 14.2% of the farmers use portions of land provided by the local cooperative societies.

Malvaceae Crop Production Characteristics in the Study Area

All the respondents were engaged in okra production (100%), but 101 (84.2%) were involved in jute mallow production, while 83 (62.2%) and 43 (35.8%) of the farmers produce roselle and cotton, respectively [Figure 2]. Kenaf was the least grown Malvaceae crop (1.7%) in the study area.

Farmers' Perception of the Most Important Constraint in the Production of Malvaceae Crops in Their Fields

The farmer considered insect pests as the most critical constraint in the production of all the Malvaceae crops investigated [Table 2]. Depending on crop type, soil fertility and plant diseases were also reported to contribute to the diminution of crop yield, but climatic factors were the least production constraints perceived by the crop farmers. The order of importance as perceived by the farmers was: insect pest > plant diseases > soil fertility > climatic factors

Table 1: Socio-economic characteristics of the farmers

Variables	Frequency	%
Gender		
Male	78	65.0
Female	42	35.0
Age		
10–20	1	0.8
21–30	8	6.7
31–40	39	32.5
41–50	49	40.8
Above 50	23	19.2
Marital status		
Single	4	3.3
Married	111	92.5
Divorced	0	0.0
Widow	4	3.3
Widower	0	0.0
Separated	1	0.8
Religion		
Christianity	112	93.3
Islam	1	0.8
Traditional	7	5.83
Tribe		
Idoma	20	16.7
Igede	20	16.7
Tiv	79	65.8
Hausa	1	0.8
Educational status		
No formal education	32	26.7
Primary/Adult education	46	38.3
Secondary	36	30.0
Tertiary	6	5.0
Primary occupation		
Farming	101	84.2
Civil Servant	16	13.3
Trading	2	1.7
Artisan	1	0.8
Secondary occupation		
Farming	19	15.8
Trading	48	40.0
Artisan	3	2.5
Others	8	6.7
No secondary occupation	42	35.0
Land ownership pattern		
Inheritance	86	71.7
Purchase	7	5.8
Rent	10	8.3
Cooperative society	17	14.2

Insect Pest Infestation and Damage Levels on Malvaceae Crops as Perceived By Farmers

In order of severity, the major insect pest reported by the farmers were flea beetles > cotton stainer > bollworms > leaf rollers > variegated grasshoppers > flower thrips > aphids pod borers > mealybugs > termites > spider mite [Table 3]. All the farmers (100%) reported the occurrence of flea beetle-induced crop damage on their farms. About 55.8% considered the damage induced to be very severe; 42.5% considered it severe, while 1.7% reported moderate levels of damage to Malvaceae crops in their farms.

All the farmers (100%) reported the occurrence of *P. sjostedti* in their field, but damage induced by *P. uniforma* was reported by 98.3% of the respondents. About 64.2% considered damage caused by *P. uniforma* to be very severe, 28.3% regarded their damage as severe; and 4.2% perceived their damage to be moderate, while two farmers (1.7%) did not observe *P. uniforma* in their farms. In addition, 44.2% of the farmers regarded *P. sjostedti* damage as very severe, while 50.8% reported severe damages and 5.0% considered damage caused by *P. sjostedti* to be moderate.

Pest Control Measures Adopted by the Farmers for the Management of Flea Beetles

About 85% of the farmers do nothing to control the pest (i.e., they use no control measure even when they observe flea beetle infestation in their farms) [Table 4]. About 84.2% use wood ash; 60% use synthetic chemical insecticides; 50% of the respondents use cropping systems against the pest; and 10% use extracts from plant materials and only one farmer (0.8%) carried out handpicking to control the pest.

Relationships between Socio-economic Characteristics of Farmers and Pest Control Methods Practiced in the Study Area

In general, there were significant ($P < 0.001$) correlations between the socio-economic characteristics of the farmers and their adopted pest control methods [Table 5]. However, the null hypothesis holds true for the relationships between handpicking of insects and the socio-economic status of the farmers. The correlations between age and use of synthetic insecticides, wood ash, marital status and the use of synthetic insecticides, cultural control, and doing nothing were positive ($P < 0.001$), while that of age and use of botanicals was negative ($P < 0.001$). Marital status and the pest control methods had significant negative correlations ($P < 0.05$). The education level of the farmers was positively correlated ($P < 0.001$) with the use of synthetic insecticides and botanicals, but it was negatively associated with the use of wood ash and doing nothing ($P < 0.001$). The correlations between the farmer's occupation and the pest control method they adopt were negative ($P < 0.001$) except for use of synthetic insecticides and botanicals which had

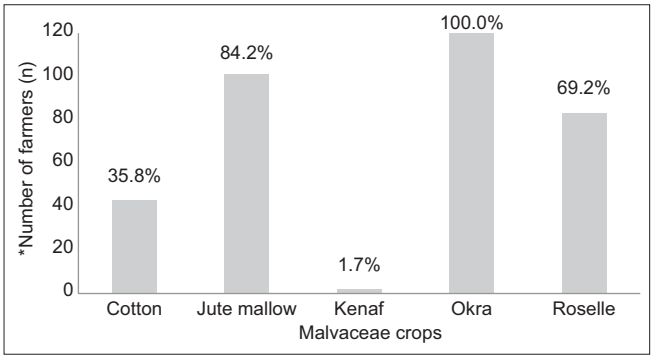

Figure 2: Malvaceae crops grown by farmers in the study area. *There were multiple responses from the farmers, hence all the frequencies did not add up to 120

significant positive correlations with the farmer's occupation ($P < 0.001$). The use of wood ash, cropping systems, and doing nothing were positively associated with farmers' years of farming experience ($P < 0.001$), but there was a significant negative correlation ($P < 0.001$) between the farmers' years of farming experience and their decision to use botanicals to control the pest.

DISCUSSION

The higher population of male Malvaceae crop farmers in the study area may be due to the cultural limitation that women in Benue State and other parts of Africa has in acquiring land for crop production. Adeogun *et al.*[26] and Uwagboe

Table 2: Farmers' perception of the most critical constraint of Malvaceae crop production

Production constraint	Okra		Jute mallow		Kenaf		Cotton		Roselle		Total responses		Ranking
	Frequency	%	Frequency	%	Frequency	%	Frequency	%	Frequency	%	Frequency	%	
Climatic factors	2	1.7	0	0	0	0	0	0.0	1	0.9	3.00	0.86	4th
Insect pest	50	41.7	89	88.1	2	100	38	88.4	41	49.5	220.00	63.04	1st
Plant diseases	27	22.5	7	6.9	0	0	5	11.6	30	35.8	69.00	19.77	2nd
Soil fertility	41	34.1	5	5.0	0	0	0	0.0	11	13.8	57.00	16.33	3rd

Number of farmers (*n*): Okra=120, Jute mallow=101, kenaf=2. Cotton=43, roselle=83

Table 3: Farmers' perception of insect pest infestation and damage levels observed on the Malvaceae crops

Major insect pests	Severity of damage										POD
	Very severe		Severe		Moderate		Mild		None		
	Frequency	%	Frequency	%	Frequency	%	Frequency	%	Frequency	%	
Aphids	18	15.0	24	20.0	1	0.8	0	0.0	77	64.2	35.8
Cotton stainer	6	5.0	42	35.0	19	15.8	12	10.0	41	34.2	65.8
Bollworms	8	6.7	41	34.2	4	3.3	9	7.5	58	48.3	51.7
Flea beetles	67	55.8	51	42.5	2	1.7	0	0.0	0	0.0	100
Flower thrips	15	12.5	22	18.3	4	3.3	4	3.3	73	60.8	39.2
Leaf rollers	1	0.8	38	31.7	10	8.3	3	2.5	68	56.7	43.3
Termites	2	1.7	5	4.2	5	4.2	3	2.5	101	84.2	15.8
Mealybugs	13	10.8	5	4.2	2	1.7	0	0.0	100	83.3	16.7
Pod borers	12	10.0	21	17.5	3	2.5	2	1.7	62	51.7	31.7
Variegated grasshoppers	1	0.8	16	13.3	9	7.5	21	17.5	72	60.0	40.0
Spider mite	8	6.7	0	0.0	0	0.0	0	0.0	112	93.3	6.7
Flea beetle species											
Podagrica sjostedti	53	44.2	61	50.8	6	5.0	0	0.0	0	0.0	100
Podagrica uniforma	77	64.2	34	28.3	5	4.2	0	0.0	2	1.7	98.3

n=120; Severity ratings: very severe ≥70% of crops in farmers' plots were damaged; severe=50 – 69% crop damage; moderate=20-49% damage; and mild=1-19% crop damage; None=No occurrence of damage; POD: Percentage occurrence of damage; Comparisons were made across each rows (severity ratings)

et al.[27] reported that female farmers in sub-Saharan Africa are constrained by social and institutional factors such as land ownership which generally reduce their ability to improve agricultural food production and the well-being of their families. Most farmers in the study area are within the active workforce age. Hence, it is expected that the adoption of pest management technologies will be easy among farmers. Agricultural information acquisition and utilization have been reported by Adesina and Baidu-Forson[28] and Uwagboe *et al*.[27] to be positively correlated with farmers' age.

Typical of most agrarian rural communities in Africa, most farmers in the study area that were above 18 years were married and this has the potential of influencing their choice of farm inputs. Ndanitsa and Umar[29] and Nwaobiala *et al*.[30] also reported that marriage and large household size in Africa is a cheaper means of providing farm labor and reducing labor costs. Furthermore, the state has more population of Christians compared to other religions, and a greater percentage of the farming population is from the Tiv tribe. This was consistent with the report of Akuma[31]. However, there was no history of any special religious/tribal affinity for or discrimination against any of the Malvaceae crop/pest management options investigated in this study.

Table 4: Pest control strategies adopted for control of flea beetles (*Podagrica* spp.) by the Malvaceae crop farmers at Benue State, Nigeria

Pest control strategies	[b]Frequency	Response (%)	Ranking
[a]Cropping systems	60	50.0	4th
Botanicals	12	10.0	5th
Do nothing	103	85.8	1st
Handpicking	1	0.8	6th
Wood ash	101	84.2	2nd
Synthetic insecticides	72	60.0	3rd

n=120 farmers; [a]cropping systems employed by farmers in the area were: crop rotation, intercropping and mixed cropping; [b]There were multiple responses from the farmers, hence all the frequencies did not add up to 120

More than 73% of the farmers had formal education (primary, secondary, and tertiary) which is an indication that they have a high potential for carrying out pest identification and management when needed. In general, education is perceived to create a favorable mental platform for formal communication, acceptance, and adoption of new practices.[32] Farming was the predominant occupation of respondents in the study area. This agrees with the previous reports by Muhammed[33] that agriculture employs nearly one-half of the labor force in developing countries. ECA[34] also reported that farming is the main source of income for 90% of the rural population in Africa. Furthermore, ownership of farmland through inheritance is a common practice in Africa. It is the practice of passing on property to family members or relatives on the death of an individual.[35] The study revealed that most of the farmlands used by farmers for Malvaceae crop production were acquired through inheritance which is usually passed on to their male children. This agrees with the finding of Emokaro *et al*.[36]

Okra was the most cultivated Malvaceae crop by farmers in the study area. Ngbede *et al*.[37] reported that okra production is widely practiced because of its importance to national economic development and can be found in almost every region of Africa

Most of the farmers perceived insect pests as the major constraint to Malvaceae crop production in the area. The farmers had adequate knowledge of the insect pests infesting their crops as most of them were able to recognize the insect pest on the pictorial section of the research instrument. They could also recognize the niche and parts of the plants damaged by the insects. They identified *P. uniforma* and *P. sjostedti* as the most damaging insect pest responsible for heavy defoliation, yield reduction, and death of their crops. This agrees with the report of Odebiyi[6], Pitan and Adewole[8], Ekoja *et al*.[10], and Adesina *et al*.[38] who implicated flea beetles in damage-causing and crop yield reduction. Furthermore, the study also showed that variegated grasshopper, cotton stainer, bollworms, leaf rollers, aphids, etc., are also, directly and indirectly, involved in damage leading to diminution of Malvaceae crop yield in the study area.

Table 5: Pearson's correlation between the socio-economic characteristics of farmers and the pest control methods practiced in Benue State, Nigeria

Socio-economic characteristics	Pest control method					
	Do nothing	Wood ash	Synthetic insecticides	Botanicals	Cropping systems	Handpicking
Age	0.364**	0.434**	0.700**	−0.475**	0.764**	−0.173
Marital status	−0.410*	−0.417*	−0.221*	−0.811**	−0.270**	−0.025
Education	−0.527**	−0.498**	0.241**	0.561**	−0.050	−0.120
Occupation	−0.952**	−0.725**	−0.329**	0.781**	−0.285**	−0.039
Years of farming experience	0.530**	0.573**	−0.410*	−0.491**	0.817**	−0.133

**Correlation is significant at $P<0.001$ level (2-tailed); *Correlation is significant at $P<0.05$ level (2-tailed). Number of observations (n) = 120

One of the important principles of insect pest management is that when the pest population reaches the economic/esthetic threshold, the use of artificial control measures is justified[9,38-40]. However, most farmers in the study area do nothing about flea beetle infestation even when the attack was very severe in their fields. This decision may be due to their low financial status and desire to achieve high output from low inputs as reported by Omolehin *et al*.[41] Ndunguru and Rjabu[42] also reported that farmers in Africa lack information on pest control methods and thus ignore the consequences of pest presence in their crop fields. However, some of the farmers indicated that they protect their crops against flea beetles using measures such as wood ash, mixed cropping, crop rotation, and synthetic chemicals. This was similar to the findings of Norman *et al*.[43] on farmers' knowledge, perception, and management of key pests of okra in Southern Sierra Leone. The use of wood ash on crop leaves to mitigate insect infestation and damage is a common practice in Africa. The pest control measure is a cheap, accessible, and potent technology used mainly by subsistent farmers.

The significant correlation between the socio-economic variable (age, marital status, education, occupation, and years of farming experience) and the pest control measures adopted by farmers in this study showed that those factors affect farmers' decisions in pest management. For instance, as the biological age and years of farmers' farming experience increase, they tend to do nothing about flea beetle attacks on their farms. However, the number of farmers that do not carry out pest control measures decreases as their education level increases, as their type of primary occupation improves, and as they got married. More farmers tend to use wood ash to dispel flea beetles as their biological age and years of farming experience increase. But the use of wood ash was not very common among farmers that were married, or with higher educational qualifications and higher-paying jobs other than farming. Furthermore, the use of synthetic insecticides in the study area was higher as farmers' age, educational, and occupational status increased. However, most of the married farmers and those with a higher number of years in the farming business were not so much involved in the use of synthetic insecticides for flea beetle control. The farmers' decision to manually handpick the adult beetles from infested plants was not significantly influenced by any of the socio-economic variables evaluated.

CONCLUSION

The study showed that *P. uniforma* and *P. sjostedti* are important yield-reducing agents in Malvaceae crop production. While most farmers do nothing to control the pest, a good number use wood ash, and some apply synthetic insecticides. It was also established that age, marital status, education, occupation, and years of farming experience confers a significant influence on farmers' choice of control measures used for flea beetle control in their farms. The training of farmers on judicious use of available insect pest control measures during Malvaceae cropping seasons is recommended as an effort that could significantly boost the production of these crops in the study area.

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REFERENCES

1. Christenhusz M, Byng J. The number of known plant species in the world and its annual increase. Phytotaxa 2016;261:201-17.
2. Hinsley SR. Economic Uses of Malvaceae Overview; 2008. Available from: http://www.malvaceae.info/economic/overview.html. [Last accessed on 2021 May 15].
3. Gerrano AS. Agronomic Performance, Nutritional Phenotyping and Trait Associations of Okra (*Abelmoschus esculentus*) Genotypes in South Africa. In: Grillo O, editors. Rediscovery of Landraces as a Resource for the Future. BoD-Books on Demand; 2018. Available from: https://www.intechopen.com/books/rediscovery-of-landraces-as-a-resource-for-the-future/agronomic-performance-nutritional-phenotyping-and-trait-associations-of-okra-abelmoschus-esculentus. [Last accessed on 2021 May 15].
4. Hill DS, Walter JM. Pests and Diseases of Tropical Crops, Principles and Control. Vol. 1. Harlow: Longman Group UK Ltd.; 1990. p. 121.
5. Pitan O, Tairu FM, Olatunde GO. Varietal differences in the resistance of *Corchorus olitorius* (Malvaceae) to the flea beetles, *Podagrica* spp. Nig J Plant Prot 2008;25:21-9.
6. Pitan O, Adewole MM. The relationship between plant chemicals in leaves of Malvaceae crops and host preference by *Podagrica sjostedti* Jacoby (Coleoptera: *Chrysomelidae*). J Agri Sci Environ 2011;11:1324.
7. Pitan OO, Ekoja EE. Yield response of okra, *Abelmoschus esculentus* (L.) Moench to leaf damage by the flea beetle, *Podagrica uniforma* Jacoby (Coleoptera: Chrysomelidae). Crop Prot 2011;30:1346-50.
8. Adesina JM, Ileke KD, Yallappa R, Ofuya TI. Insecticidal evaluation of *Bridelia micrantha* and *Dalbergia lactea* aqueous extracts for the control of *Podagrica uniforma* (Jacoby) and *Nisotra dilecta* (Jacoby) (Coleoptera: Chrysomelidae) infestation on okra. Agrivita J Agric Sci 2016;38:269-74.
9. Pitan OO, Ekoja EE. Growth inhibition and fruit distortion in okra (*Abelmoschus esculentus*) induced by the flea beetle *Podagrica uniforma* (Coleoptera: Chrysomelidae) herbivory. Int J Trop Insect Sci 2012;32:210-7.
10. Odebiyi JA. Relative abundance and seasonal occurrence of *Podagrica* spp. (Coleoptera: Chrysomelidae) on okra in Southwestern Nigerian. Afr J Agric Res 1980;6:83-4.
11. Atiri GI. The occurrence and importance of okra mosaic virus in Nigerian weeds. Ann Appl Biol 1984;104:261-5.
12. Vanlommel S, Duchateau L, Coosemans J. The effect of okra

mosaic virus and beetle damage on yield of four okra cultivars. Afr Crop Sci J 1996;4:71-7.
13. Emosairue SO, Uguru EI. Field trial of aqueous and petroleum ether extracts of *Monodora myristica* (Gaertn.) dunal and *Jatropha curcas* L. for the control of okra flea beetles, *Podagrica* spp. J Appl Agric Res 1999;6:100-4.
14. Mohammed MM. Studies on the Control of Insect Pests in Vegetables (Okra, Tomato, and Onion) in Sudan with Special Reference to Neem Preparations. Dissertation for Obtaining a Doctorate Degree in Agricultural Science. Sudan: Institute of Phytopathology and Applied Zoology Justus-Liebig-University of Giessen; 2000. p. 20-32. Available from: https://geb.uni-giessen.de/geb/volltexte/2001/410/pdf/d010011. [Last accessed on 2020 March 10].
15. Anaso CE, Lale NE. Spraying intervals and cost-benefit of using aqueous neem kernel extract and deltamethrin against some foliage and fruit pests of okra in Sudan savanna of Nigeria. J Sustain Agric 2002;4:122-8.
16. Onunkun O. Evaluation of aqueous extracts of five plants in the control of flea beetles on okra (*Abelmoschus esculentus* (L) moench). Biopestic 2012;5:62-7.
17. Ahmed BI, Yusuf SR, Garba AA, Mustapha S. Effect of cropping arrangements and rainfall on the performance of okra (*Abelmoschus esculentus* (L)Moench) in Bauchi State, Nigeria. Emir J Food Agric 2006;18:1-9.
18. Pitan OO, Olatunde GO. Effects of intercropping tomato (*Lycopersicon esculentum*) at different times with cowpea (*Vigna unguiculata*) or okra (*Abelmoschus esculentus*) on crop damage by major insect pests. J Agric Sci 2006;144:361-8.
19. Kughur PG, Okeme S, Katikpo G. Assessment of adoption of integrated pest management practices among cowpea farmers in Okpokwu local Government area of Benue state, Nigeria. Prod Agri Tech J 2017;13:27-39.
20. Afolabi JA, Thompson OA, Ogunwande IO, Olasunkanmi NO. Assessment of barriers to integrated pest management practice among maize farmers in Southwest, Nigeria. Eur J Sci Res 2020;157:395-407.
21. Yusuf V, Idris, M. Issues FG Must Fix to Regain Cotton Glory; 2021. p. 1. Available from: https://dailytrust.com/issues-fg-must-fix-to-regain-cotton-glory. [Last accessed on 2022 January 10].
22. Youri D, Jimi T, Likoko E. Scoping study on fruits and vegetables: Results from Nigeria. Netherlands: Wageningen Economic Research; 2021. p. 1-72. Available from: https://edepot.wur.nl/554350. [Last accessed on 2022 January 10].
23. Agada MO. Technological capabilities among soybean producers in Benue state, Nigeria. J Bio Agric Health 2014;4:1.
24. Bepeh JP. Naturally Endowed Benue Laden with Poverty; 2017. Available from: https://leadership.ng/2017/08/09/naturally-endowed-benue-laden-poverty [Last accessed on 2021 Dec 12].
25. GENSTAT. General Statistics Software, Version 19. Hempstead, UK: VSN International, Hemel; 2017.
26. Adeogun SO, Olawoye JE, Akinbile LA. Information sources to cocoa farmers on cocoa rehabilitation techniques (CRTs) in selected states of Nigeria. J Med Commun Stud 2010;2:9-15.
27. Uwagboe EO, Meludu NT, Agbebaku EE. Adoption of integrated pest management among cocoa farmers in cross river and Osun states of Nigeria. J Agric Ext 2016;20:35-40.
28. Adesina AA, Baidu-Forson J. Farmers' perceptions and adoption of new agricultural technology: Evidence from analysis in Burkina Faso and Guinea, West Africa. Agric Eco 1995;13:1-9.
29. Ndanitsa MA, Umar IS. The Method of Storage of Farm Produces by Farmers in Niger State of Nigeria. Proceedings of the 10th Annual Conference of Nigerian Association of Agricultural Economists (NAAE) Held at Abuja; 2008. p. 174-82.
30. Nwaobiala CU, Isiocha SC, Nwachukwu K. Adoption of cassava postharvest technologies by women in Ivo LGA. of Ebonyi State, Nigeria. Proceedings of the 43rd Annual Conference of Agricultural Society of Nigeria/ASN) Abuja; 2009. p. 670-2.
31. Akuma SS. A Road Map to a Greater Tiv Nation through Agriculture and Information and Communication Technology, ICT; 2019. Available from: https://mutuk.org/?p=189
32. Pimentel D. Handbook of Pest Management in Agriculture. Vol. 1. 2nd ed. Boca Raton, FL: CRC Press; 1991. p. 765.
33. Muhammed MA. Rural Development and Enterprise Development. Alexandria: Sustainable Development Association; 2007. p. 73-88.
34. Economic Commission for Africa. Africa Review Report on Agriculture and Rural Development. Addis Ababa: Fifth Meeting of the Africa Committee on Sustainable Development; 2007. p. 22-5.
35. Bowles S, Gintis H. The inheritance of inequality. J Econ Perspect 2002;16:3-30.
36. Emokaro CO, Ekunwe PA, Osifo A. Profitability and production constraints in dry season amaranth production in Edo South, Nigeria. J Food Agric Environ 2007;5:281-3.
37. Ngbede SO, Ibekwe HN, Okpara SC, Onyegbule UN, Adejumo L. An overview of okra production, processing, marketing, utilization and constraints in Ayaragu in Ivo local Government area of Ebonyi state, Nigeria. Greener J Agric Sci 2014;4:136-43.
38. Ekoja EE, Pitan OO, Ataiyese MO. Physiological response of okra to flea beetle herbivory as measured by leaf loss, chlorophyll disruption, and dry matter yield. Int J Veg Sci 2012;18:171-81.
39. Pedigo LP, Rice ME. Entomology and Pest Management. 6th ed. United States: Waveland Press Inc.; 2009. p. 742.
40. Bunn B, Alston D, Murray M. Flea Beetles on Vegetables (Coleoptera: Chrysomelidae). Utah State University Extension and Utah Plant Pest Diagnostic Laboratory; 2015. p. 174-15.
41. Omolehin RA, Ogunfiditimi TO, Adeniji B. Factors influencing adoption of chemical pest control in cowpea production among rural farmers in Makarfi local Government area of Kaduna state, Nigeria. Int J Agric Res 2007;2:920-8.
42. Ndunguru J, Rajabu AC. Effect of okra mosaic virus disease on the aboveground morphological yield components of okra in Tanzania. Sci Hortic 2004;99:225-35.
43. Norman JE, Kanteh S, Samura AE, Mansaray A. Farmer's knowledge, perception and management of key pests of okra, *Abelmoschus esculentus* (L.) moench in Southern Sierra Leone. J Harmonized Res Appl Sci 2014;2:328-40.