International Journal of Agricultural Research

ISSN 1816-4897

Academic Journals Inc.

www.academicjournals.com

OPEN ACCESS International Journal of Agricultural Research

ISSN 1816-4897
DOI: 10.3923/ijar.2017.146.155

Research Article
Farmers' Perceptions on Arthropod Pests of Watermelon and their Management Practices in the Nigerian Southern Guinea Savanna

[1]Emmanuel Okrikata and [2]Emmanuel Oludele Ogunwolu

[1]Department of Biological Sciences, Federal University Wukari, Taraba State, Nigeria
[2]Department of Crop and Environmental Protection, University of Agriculture, P.M.B. 2373, Makurdi, Benue State, Nigeria

Abstract

Background and Objective: Watermelon is adapted to a wide variety of agro-ecology and has high nutritive, therapeutic and income generating values. Arthropod pests remain its major productivity constraint around the World. Productivity can be enhanced through pest management researches that consider farmers' knowledge gaps and indigenous control practices. This study is designed to determine the watermelon farmers' knowledge and perceptions on arthropod pests and their indigenous control strategies within the Nigerian Southern Guinea Savanna zone. **Materials and Methods:** A structured questionnaire was administered to 129 randomly selected farmers across 3 local government areas (LGA) in each of Benue, Nasarawa and Taraba states of Nigeria under the guide of agricultural extension and communication officers in 2015. The responses elicited include farming practices, production profiles, perception and attitudes of farmers toward pests, pest damage and pest control practices. The data collected were analyzed using descriptive and inferential (Fisher's exact test) statistics using SPSS 19.0. **Results:** There were no significant differences among states in socio-economic characteristics (gender, age and level of education) and cropping system. However, Fishers exact test showed significantly ($p<0.05$) higher proportion of farmers with 5<15 years farming experience in Nasarawa state (51.1%) when compared with Benue state (4.4%). A similar trend was observed on proportion of farmers cultivating large hectarages (>4ha). Across the 3 states, 68.5% of the respondents identified leaf beetles as the major biological constraint. In Gassol LGA of Taraba state, *Agnoscelis versicolor* was also designated a major pest. Infestation and damage by aphids, fruit-flies and millipedes was of serious concern to 8.4, 6.3 and 5.3% of the respondents, respectively. A large proportion of the respondents had no contact with extension service providers or with extension publications on pest control. Suppression of pest damage with synthetic insecticides was prevalent (done by 79.7% of the respondents). Spray frequencies were as outrageous as 25 times on the early-sown crop. **Conclusion:** This study finding underscores the need to revitalize extension services and educate farmers on pest recognition and judicious pesticide usage in watermelon production as most of the respondents depended on family, friends and pesticide vendors for pest control information.

Key words: *Agnoscelis versicolor*, arthropod pest, *Citrullus lanatus*, chrysomelid beetles, fisher's exact test, multi stage

Citation: Emmanuel Okrikata and Emmanuel Oludele Ogunwolu, 2017. Farmers' perceptions on arthropod pests of watermelon and their management practices in the Nigerian Southern Guinea Savanna. Int. J. Agric. Res., 12: 146-155.

Corresponding Author: Emmanuel Okrikata, Department of Biological Sciences, Federal University Wukari, Taraba State, Nigeria Tel: +2348060853366

Competing Interest: The authors have declared that no competing interest exists.

Data Availability: All relevant data are within the paper and its supporting information files.

INTRODUCTION

Watermelon (*Citrullus lanatus* Thunb.) is adapted to a wide variety of agro-ecology[1,2]. Its cultivation spans through several countries in Africa, America, Asia and Europe[2-4]. It has immense benefits to man due to its high nutritive (richness in vitamins A, C, potassium, magnesium and iron), therapeutic (possession of diverse anti-oxidants, diuretic, cancer and hypertension reducing properties) and economic (income generation and valuable contribution to national gross domestic product) values[5-7]. Hitherto in Nigeria, commercial production of watermelon was preponderantly in the Savanna agro-ecology; awareness of its high economic value[4,8-10] has encouraged more people to embark on its cultivation in other agro-ecological zones of Nigeria. Across all production zones, minimization of cost and maximization of production efficiency and profit[11] are common goals which are not commonly achieved on account of the diversity of farmers' value system, experience, needs, production technology and efficiency and environmental challenges (productivity-limiting climatic, edaphic and biotic factors)[12,13]. It is thus expedient to carry out location-specific assessment of crop performance.

Insect depredation negatively impacts farm and farmer productivity in both garden and commercial cultivation of watermelon[14]. Capacity to mitigate damage depends upon farmer's perception on pest damage impact and availability and accessibility to the recommended and adoptable pest management tactics. Wide gaps in farmers' knowledge on bio-ecology and status of pests as well as farmers' inclination towards indigenous pest management tactics limit production efficiency and profitability[15,16]. Productive capacity and efficiency can be enhanced meaningfully through pest management research that takes cognizance of farmers' needs, values, knowledge gaps, indigenous control practices and skill in resource utilization[13,17-22]. Pest management research and recommendations are scanty in many parts of the world where commercial watermelon production is new.

Understanding farmers' indigenous knowledge and perceptions on pest challenges and their coping strategies is important in designing researches that will meet the needs of the farmers and solutions found, easily adopted[23,24]. Such information is scarce with regards to watermelon in Nigeria and specifically, within the Nigerian Southern Guinea Savanna agro-ecology where commercial cultivation of watermelon is relatively new. This survey is therefore designed to determine the perceptions of watermelon farmers regarding pests in general and arthropod pests in particular and, their control strategies at selected sites within the Southern Guinea Savanna zone of Nigeria.

MATERIALS AND METHODS

The study was carried out between June and August, 2015. A total of 129 farmers from 43 villages (all within the Southern Guinea Savanna agro-ecology of Nigeria) spread across 9 local government areas (LGAs) in 3 states were selected for the study following a multistage sampling technique. Benue, Nasarawa and Taraba states were purposively selected based on expanding interest in commercial watermelon production. Within each of the 3 states, 3 LGAs and within each LGA, 5 villages (except, Donga LGA of Taraba state where 3 villages were visited) were again purposively selected based on the volume of watermelon production. In each village, 3 watermelon farmers were randomly selected for the interview. The survey sites and co-ordinates are shown in Table 1 and Fig. 1.

Data were collected through a face-to-face interview using a structured questionnaire under the guide of indigenous agricultural extension officers. This was complemented with field observation to validate information on pest identity and the damage they cause. The questionnaire was peer-reviewed and pilot-tested on 15 farmers (not included in the sample), 2 weeks before the commencement of the study after which a few changes were made in the expression of some of the questions after also taking into consideration the inputs of the extension officers. The information gathered through the questionnaire traversed demographics, farming practices, production profiles, perception and attitudes of farmers toward pests, pest damage and pest control practices.

Statistical analysis: The data collected were subjected to descriptive and inferential fisher's exact test (FET) statistics using SPSS version 19.0 (SPSS Inc., Chicago, Illinois). Following the methods of Nantoume *et al.*[25] and Sales *et al.*[26], FET was used to compare the variables constituting farmers' characteristics among states surveyed and to determine association between farmers' characteristics and insecticide spraying frequencies. The probability value (p-value) was estimated using the two sided test at 5% level of significance.

RESULTS AND DISCUSSION

In commercial crop farming, age, education, farming experience, contact with extension workers and membership of co-operative societies are known to exert significant impact on technical efficiency of farmers[10,27,28]. Table 2 shows respondents' socio-economic characteristics, whereas states

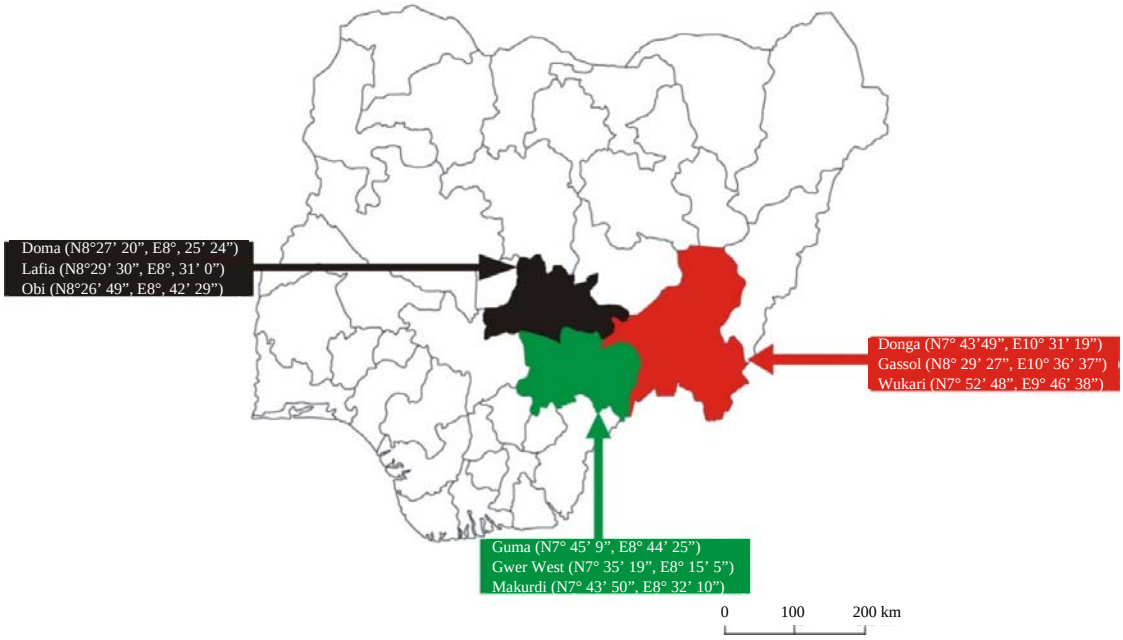

Fig. 1: Map of Nigeria indicating states and local government areas surveyed

Source: Satellite Maps (2015)

Table 1: List of villages surveyed with their coordinates and respective local government areas

States	LGA	Villages/coordinates				
Benue state	Guma	Abinsi/	Ageraza/	Tse-Alashi/	Adzom/	Tse-Adzer/
		N7°45′9.7″	N7°43′55.2″	N7°44′19″	N7°43′33″	N7°44′28.3″
		E8°44′25″	E8°47′24.5″	E8°47′4.6″	E8°48′45.3″	E8°46′24.5″
	Gwer West	Tse Taav/	Chia/	Kula/	Tse-Abena/	Jimba/
		N7°35′19.4″	N7°35′57.9″	N7°31′10.1″	N7°38′12.1″	N7°38′0.6″
		E8°15′4.5″	E8°17′17.6″	E8°22′56.5″	E8°24′28.8″	E8°20′34.3″
	Makurdi	Fiidi/	Tyomu/	Antsah/	Tse-Atungu/	Passbrother/
		N7°42′53.7″	N7°42′53.1″	N7°46′9.3″	N7°35′19.4″	N7°44′47.3″
		E8°38′20″	E8°40′7.6	E8°35′14.6″	E8°15′4.5″	E8°43′23.7″
Nasarawa state	Doma	Iwashi/	Ruttu/	Wangye/	Doma/	Kawu/
		N8°24′53.3″	N8°25′56.4″	N8°27′20.7″	N8°23′55.3″	N8°26′59.4″
		E8°17′46.8″	E8°14′15.3″	E8°25′24.5″	E8°21′28.6″	E8°24′57.5″
	Lafia	Akurba/	Agudu/	Kan Tsakuwa/	Akunza Jarme/	Ungwan Ayaba/
		N8°29′11.1″	N8°27′56.2″	N8°28′12.7″	N8°28′8.5″	N8°28′5.2″
		E8°31′41.2″	E8°37′40.3″	E8°36′30.3″	E8°36.6′6.9″	E8°37′3.4″
	Obi	Ungwan Sule/	Akwade Kasuwa/	Daddere/	Ungwan Mamman/	Ungwan Hamidu/
		N8°27′25.6″	N8°26′50.5″	N8°26′49.5″	N8°27′17.7″	N8°27′26.4″
		E8°41′5.2″	E8°38′48.8″	E8°42′29.3″	E8°41′37.3″	E8°40′51.7″
Taraba state	Donga	Akate/	Fada/	Gyatta Aure/		
		N7°43′4″	N7°43′49.1″	N7°43′38.4″		
		E10°31′19″	E10°2′33.4″	E10°2′29.7″		
	Gassol	Garin Karfe/	Kwararafa/	Garko/	Mararaban Gassol/	Tella/
		N8°28′6.4″	N8°15′27.1″	N8°27′24″	N8°29′27″	N8°23′56.7″
		E10°35′41.1″	E10°22′26.4″	E10°35′8.9″	E10°36′37″	E10°31′19″
	Wukari	Byepyi/	Nwuhwa/	Avyi 2/	Avyi 1/	Wukari/
		N7°55′37.5″	N7°57′41″	N7°57′12.8″	N7°50′37″	N7°50′37″
		E9°52′1.4″	E9°55′25.2″	E9°57′10.8″	E9°46′31″	E9°46′31″

differed significantly ($p<0.05$) with respect to farm size and farming experience, the differences in gender, age range and level of education were due to random variation. Male dominance of watermelon production was evident (mean ratio of 8:1 with a range from 4.6:1-21.5:1) similar to the findings of Banjo *et al.*[29] and Yusuf *et al.*[30]. This may be

Table 2: Socio-economic characteristics and cropping system of sampled watermelon farmers

Variable	Benue state (n = 45)	Nasarawa state (n = 45)	Taraba state (n = 39)	Mean (%)	p-value[##]
Gender					0.127ns
Male	37 (82.2)[#]	43 (95.6)	35 (89.7)	89.2	
Female	08 (17.8)	2 (4.4)	4 (10.3)	10.8	
Age range (years)					0.387ns
10-20	0 (0.0)	4 (8.9)	3 (7.7)	5.3	
21-30	8 (17.8)	7 (15.6)	8 (20.5)	18.0	
31-40	21 (46.7)	17 (37.8)	15 (38.5)	41.0	
41-50	11 (24.4)	8 (17.8)	10 (25.6)	22.6	
>50	5 (11.1)	9 (20.0)	3 (7.7)	13.0	
Educational level					0.14ns
Non-formal	9 (20.0)	22 (48.9)	16 (41.0)	36.6	
Primary school	17 (37.8)	10 (22.2)	12 (30.8)	30.3	
Secondary school	15 (33.3)	10 (22.2)	9 (23.1)	26.2	
Tertiary institution	4 (8.8)	3 (6.7)	2 (5.1)	6.9	
Farming experience (years)				<0.001**	
<1	12^{a+} (26.7)	3^{b} (6.7)	$6^{a,b}$ (15.4)	16.3	
1-<5	31^{a} (68.9)	19^{b} (42.2)	$19^{a,b}$ (48.7)	53.3	
5-<10	2^{a} (4.4)	18^{b} (40.0)	10^{b} (25.6)	23.3	
10-<15	0^{b} (0.0)	5^{a} (11.1)	4^{a} (10.3)	7.1	
Farm size (ha)/scale of production[$]					0.04*
<1/Small	28^{a} (62.2)	13^{b} (28.9)	$16^{a,b}$ (41.0)	44.0	
1-<2/Medium	10^{a} (22.2)	11^{a} (24.4)	8^{a} (20.5)	22.4	
2-<3/Medium	4^{a} (8.9)	8^{a} (17.8)	5^{a} (12.8)	13.2	
3-<4/Medium	3^{a} (6.7)	5^{a} (11.1)	3^{a} (7.7)	8.5	
4-<5/Large	0^{a} (0.0)	6^{b} (13.3)	5^{b} (12.8)	8.7	
≥5/Large	0^{a} (0.0)	2^{a} (4.4)	2^{a} (5.1)	3.2	
Cropping system					0.06ns
Intercrop	19 (42.2)	9 (20.0)	10 (25.6)	29.1	
Sole crop	26 (57.8)	36 (80.0)	29 (74.4)	70.7	

[#]Percentage of respondents, [##]Fisher's exact test p-value, *Significant (p<0.05), **Significant (p<0.01), ns = Not significant (p>0.05). +Each superscript letter denotes a subset of categories whose row proportions do not differ significantly by Fisher's exact test (p>0.05). [$]Adapted from Benjamin *et al.*[23]

attributable to the easier access men have to land and economic empowerment[31-33]. Given the reports by Benjamin *et al.*[23] and Okonya *et al.*[34] on female efficiency in fruit and vegetable production and given the livelihood enhancement potential of watermelon, more women should be encouraged and empowered to go into production.

As pointed out by Adenegan *et al.*[35], age significantly influences farm and farmer productivity. Table 2 shows that in each state and across the three states, the age bracket with the highest frequency of respondents was 31-40 years. As high as 63.6% of the respondents were in the age bracket (30-50 years) designated by Oladoja *et al.*[36] and Olaniran *et al.*[24] as active in the highly labour-intensive peasantry farming. Approximately one-third of the respondents had no formal education (the sample in Nasarawa state had the highest proportion of respondents in this category) and just about the same proportion (one-third) had primary level education. Banjo *et al.*[29] similarly found that most farmers growing horticultural crops in Southwestern Nigeria had no formal education. This has implication for farmers' efficiency in production, decision-making, openness to innovative ideas and new technologies and is the key to enhanced productivity[37-39].

Commercial cultivation of watermelon generally seems to be a recent development in the areas surveyed. Farming experience was <15 years compared with 2-33 years in areas surveyed in Kano and <5->20 years in areas surveyed in Moro LGA of Kwara state[1,9]. Majority (69.6%) of the respondents had ≤5 years experience; Benue state had the highest proportion of respondents with <1-<5 years farming experience; the proportions for Nasarawa and Taraba states were significantly lower (Table 3). In the 5 to <15 years category, the latter two states were statistically comparable (51.1 and 35.9%, respectively) but each differed significantly from Benue state. Based on the scale of production given by Benjamin *et al.*[23], watermelon production in the areas surveyed generally ranged from small- (<1.0 ha) to medium-scale (1.0-<4.0 ha). Across the states, commercial production of watermelon was generally small-scaled with 44.0% of the respondents cultivating <1 ha. This value is considerably ≤70.0% reported by Chamo *et al.*[40] in their survey of Gada Community, Jigawa state, Nigeria. Benue state had the highest proportion of

Table 3: Farmers' cropping system in different states

Variables	Benue state (n = 45)	Nasarawa state (n = 45)	Taraba state (n = 39)	Mean (%)
Variety planted				
Sugar baby	06 (13.3)*	8 (17.8)	05 (12.8)	14.60
Kaolack	29 (64.4)	28 (62.2)	26 (66.7)	64.40
Charleston gray	4 (8.9)	6 (13.3)	5 (12.8)	11.70
Unknown	12 (26.7)	9 (23.1)	9 (23.1)	24.00
Reason for selection#				
Nutritive value	3 (6.7)	0 (0.0)	1(2.6)	3.10
High yield	18 (40.0)	20 (44.4)	15 (38.5)	41.00
Market value	20 (44.4)	17 (37.8)	16 (41.0)	41.10
Adaptation to environment	9 (20.0)	10 (22.2)	5 (12.8)	18.30
Pest resistance	1 (2.2)	0 (0.0)	0 (0.0)	0.73
Availability	22 (48.9)	21 (46.7)	18 (46.2)	47.30
Source of seeds#				
Agrochemical stores	25 (55.6)	27 (60.0)	18 (46.2)	53.90
Previous harvest	20 (44.4)	18 (40.0)	17 (43.6)	42.70
Other farmers	9 (20.0)	5 (11.1)	4 (10.3)	13.80
Planting period#				
April/May (Early)	12 (26.7)	15 (33.3)	14 (35.9)	32.00
August/September (Late)	35 (77.8)	37 (82.2)	31(80.0)	80.00
November/December (Dry season)	10 (22.2)	5 (11.1)	10 (25.6)	19.60

*Percentage of respondents. #Multiple choice allowed

small-scale farmers. Differences among states in the proportions of respondents producing at medium and large scale were not significant. Results of the surveys conducted in Ekiti state[9], Kano state[1] and Kwara state[30] similarly showed preponderance of small-scale producers of watermelon.

Watermelon was preponderantly monocropped (70.7% of respondents against 29.1% who intercropped) and rainfed (just 19.6% of respondents produced irrigated crop). The low production in the early season is attributed high intensity production of food crops, higher pest infestation of watermelon, low yield and low market value[41]. For varietal selection, higher premium was placed on crop yield, market value, availability of seeds than on avoidance of pest infestation and damage. A similar finding was reported by Alghali[42] in a study of cowpea farming practices in Nigeria. Association of watermelon producers was virtually non-existent; the only one found was in Ruttu village, Nasarawa state.

Arthropods were designated the most frequently encountered, abundant and economically damaging pests causing quantitative and qualitative losses as well as increasing production cost because of insecticide usage to mitigate damage (Table 4). Insects, most notably beetles, were the predominant arthropods and the most productivity-limiting. This is consistent with the findings of Alao *et al.*[43] who monitored insect infestation on watermelon at Ogbomoso. Also, rural farmers producing fruit vegetables in Ogbomoso had accorded major pest status to insect pests[24]. Except for the wrong designation of bees as pests by 10.2% of the respondents, all other insects listed as pests in Table 4 agrees with the report of Ogunlana[44], Bamaiyi *et al.*[45] and Alao *et al.*[43]. According to Webb[46], bees are very important watermelon pollinators that require protection, attraction and even augmentation during the crop's blooming period. In this study, a pentatomid bug, *Agnoscelis versicolor* F., was found in Gassol LGA of Taraba state where it was accorded major pest status. This is the first report of infestation of *A. versicolor* on watermelon in Nigeria. However, across northeast Africa and southwest Asia, a species of *Agnoscelis* has been reported to attack cucurbits including watermelon[47].

An insignificant proportion of the respondents ($\bar{x} = 6.3\%$) took no control action to mitigate arthropod pest damage (Table 5); there were at least two of such respondents in each State. Application of synthetic insecticides was the prevalent method of control ($\bar{x} = 88.9\%$) (Table 5). The commonly used insecticides were lambda cyhalothrin (Karate), cypermethrin (Best), permethrin powder (Pif Paf), cypermethrin+ dimethoate (best action) and pirimiphos-methyl+permethrin (Attack). Spray frequency traversed 1 to >25 per growing season (Fig. 2) and it was not significantly influenced by any of the respondent's socio-economic characteristics except gender (Table 6). Male farmers have been shown to use pesticides more often and at a higher rate than their female counterparts[48,49]. In contrast, in the study by Denkyirah *et al.*[50], significant association was shown between each of level of education and farming experience and the frequency of pesticide application on cocoa in Ghana.

Not surprisingly, majority of the respondents ($\bar{x} = 77.7\%$) protected the seedling and vegetative growth stages of watermelon having recognized that leaf beetles impacted

Table 4: Farmers' perceptions on pests of watermelon

Variables	Benue state (n = 45)	Nasarawa state (n = 45)	Taraba state (n = 39)	Mean (%)
Most problematic pest				
Arthropods	41 (91.1)*	40 (88.9)	34 (87.2)	89.1
Rodents	0 (0.0)	0 (0.0)	1 (2.6)	0.9
Birds	0 (0.0)	1 (2.2)	1 (2.6)	1.6
Weeds	1 (2.2)	2 (4.4)	0 (0.0)	2.2
Pathogens	3 (6.7)	2 (4.4)	3 (7.7)	6.3
Reason for high rating[#,$]				
Reduce quantity of yield	32 (78.0)	35 (87.5)	29 (85.3)	83.6
Reduce quality of yield	33 (80.5)	31 (77.5)	29 (85.3)	81.1
Increase cost of production	24 (58.5)	26 (65.0)	16 (47.1)	56.9
Frequently encountered arthropod pest[$]				
Beetles	43 (95.6)	45 (100.0)	37 (94.9)	96.8
Grasshoppers	2 (4.4)	2 (4.4)	2 (5.1)	4.6
Aphids	15 (33.3)	17 (37.8)	7 (18.0)	29.7
Stink bugs	0 (0.0)	0 (0.0)	11 (28.2)	9.4
Fruit flies	5 (11.1)	15 (33.3)	12 (30.8)	25.1
Millipedes	5 (11.1)	10 (22.2)	8 (20.5)	17.7
Caterpillars	4 (8.9)	5 (11.1)	4 (10.3)	10.1
Whiteflies	4 (8.9)	4 (8.9)	3 (7.7)	8.5
Cricket	0 (0.0)	5 (11.1)	2 (5.1)	5.4
Termites	0 (0.0)	3 (6.7)	2 (5.1)	3.9
Bees	3 (6.7)	5 (11.1)	5 (12.8)	10.2
Most abundant arthropod pest				
Beetles	40 (88.9)	39 (86.7)	24 (61.5)	79.0
Stink bugs	0 (0.0)	0 (0.0)	10 (15.4)	8.5
Aphids	3 (6.7)	3 (6.7)	2 (5.1)	6.2
Fruit flies	1 (2.2)	3 (6.7)	3 (7.7)	5.5
Most damaging arthropod pest				
Beetles	33 (73.3)	33 (73.3)	23 (59.0)	68.5
Fruit flies	2 (4.4)	3 (6.7)	3 (7.7)	6.3
Aphids	5 (11.1)	4 (8.9)	2 (5.1)	8.4
Stink bugs	0 (0.0)	0 (0.0)	9 (23.1)	7.7
Caterpillars	2 (4.4)	2 (4.4)	1 (2.6)	3.8
Millipedes	3 (6.7)	3 (6.7)	1 (2.6)	5.3

*Percentage of respondents. [#]Responses of those who rated arthropods as most important only. [$]Multiples responses allowed

Table 5: Adopted methods of arthropod pest control on watermelon

Variables	Benue state (n = 45)	Nasarawa state (n = 45)	Taraba state (n = 39)	Mean (%)
Method of control[#]				
No control measure	3 (6.7)*	2 (4.4)	3 (7.7)	6.3
Mechanical control	9 (20.0)	8 (17.8)	9 (23.1)	20.3
Use of pest resistant varieties	0 (0.0)	0 (0.0)	0 (0.0)	0.0
Use of synthetic insecticides	40 (88.9)	42 (93.3)	33 (84.6)	88.9
Timely harvesting	10 (22.2)	15 (33.3)	10 (25.6)	27.0
Disposal of infested fruits	12 (26.7)	18 (40.0)	8 (20.5)	29.1
Use of botanical insecticides	6 (13.3)	8 (17.8)	7 (18.0)	16.4
Use of wood ash+permethrin powder	4 (8.9)	2 (4.4)	2 (5.1)	6.1
Use of washing powder solution	3 (6.7)	5 (11.1)	2 (5.1)	7.6
Use of faecal powder of goat	2 (4.4)	0 (0.0)	1 (2.6)	2.3
Most critical stage of insecticide application[$]				
Seedling	23 (57.5)	24 (57.1)	19 (57.6)	57.4
Vegetative	7 (17.5)	8 (19.1)	8 (24.2)	20.3
Flowering	6 (15.0)	4 (9.5)	3 (9.09)	11.2
Fruiting	4 (10.0)	6 (14.3)	3 (9.09)	11.1

*Percentage of respondents. [#]Multiple choice allowed. [$]Responses of those using synthetic insecticides

negatively on crop productivity. Synthetic insecticide usage in the area surveyed can be adjudged injudicious and hazardous. It could not have been otherwise given the paucity of contact of respondents with agricultural extension personnel or agricultural extension publication and the overwhelming dependence ($\bar{x}$ = 72.3%) upon pesticide marketers and

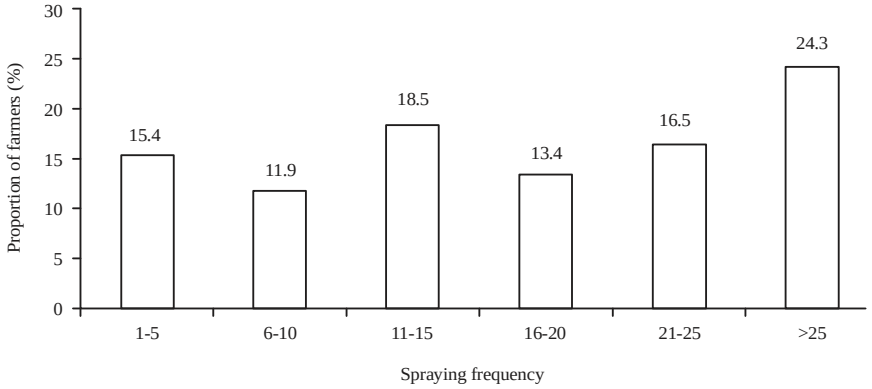

Fig. 2: Frequency of application of synthetic insecticides/growing season

Table 6: Farmers' source of information on pest control

Source#	Benue state (n = 45)	Nasarawa state (n = 45)	Taraba state (n = 39)	Mean (%)
Family and friends	22 (49.0)*	24 (53.3)	19 (48.7)	50.3
Pesticide vendors/marketers/peddlers	30 (66.7)	33 (73.3)	30 (76.9)	72.3
Radio/television programmes	3 (6.7)	2 (4.4)	1 (2.6)	4.6
Agricultural extension officers	0 (0.0)	5 (11.1)	0 (0.0)	3.7
Agricultural extension publication	0 (0.0)	0 (0.0)	0 (0.0)	0.0
Internet	2 (4.4)	0 (0.0)	0 (0.0)	1.5
None	1 (2.2)	2 (4.4)	1 (2.6)	3.1

*Percentage of respondents. #Multiple responses allowed

Table 7: Association between farmer's characteristics and frequency of application of insecticides/growing season

Farmer's characteristics	Fisher's exact test p-value
Gender	0.025*
Age (years)	0.813ns
Educational level	0.691ns
Farming experience (years)	0.720ns
Farm size/scale of production (ha)	0.567ns
Cropping system	0.639ns

*Significant at p<0.05, ns = Not significant (p>0.05)

vendors as source of information on pest control (Table 7). Mahmud *et al.*[51] and Akan *et al.*[52] have already documented organophosphate, pyrethroid and organochlorine insecticide residue above the maximum limits set by the European Union on watermelon in some parts of Gashua LGA of Yobe State. Other consequences of inappropriate insecticide usage in general and in watermelon production in particular have been highlighted by Souza *et al.*[53]. The other pest control methods adopted: Cultural (disposal of infested fruits and timely fruit harvest), mechanical destruction of pests, application of ash, washing powder solution, plant- and animal-derived insecticide minutely contributed to pest damage mitigation.

Ibrahim *et al.*[10] reported that years of farming experience, extension and membership of co-operative society were the main sources of technical inefficiency. It is obvious that respondents who applied insecticides frequently have not weighted its impact on their production cost and revenue. In addition to limiting farmers' technical efficiency and profitability, injudicious usage insecticides will have far-reaching consequences on agro-ecosystem and environment. The knowledge gap has to be bridged through research to generate recommendation on adoptable pest density/damage level at which insecticide usage is justified and bridged through on-farm demonstration and farmer education.

CONCLUSION

The survey results highlight a generally high level of farmers' awareness on the economic impact of insect pests to watermelon production. The chrysomelid beetles reported to be the most devastating except in Gassol LGA, Taraba state where *A. versicolor* was reported as the most devastating. Pesticide use among the farmers was also very high and quite extensive. There is, therefore, a serious need for field education of farmers on judicious use of pesticides to protect insect pollinators (primarily bees), natural enemies of insect pests, the environment and most importantly, man. A huge gap in extension services was also show cased. This requires that the government and/or the related agencies make deliberate efforts to revitalize extension services. Based on the

study findings, it is suggested that further study in this study area should examine pesticide related health issues such as reproductive abnormalities, pesticide poisonings and musculoskeletal pains as a result of occupational contact with pesticides.

SIGNIFICANCE STATEMENTS

This study discovers the needs, knowledge and perceptions on pest problems and their control by local watermelon farmers in Southern Guinea agro-ecology of Nigeria. This information is unavailable. This study will help the researcher to uncover farmers' perceptions of pests and their indigenous control methods. This information will be beneficial for researchers in pest management as it is a prerequisite for developing successful pest management strategies.

ACKNOWLEDGMENTS

The authors greatly acknowledge all the farmers who were interviewed in this research for willingly providing all the information demanded from them. The authors are also thankful to the following extension officers for their unflinching support during the execution of this research; Mr. Innocent Tarnzughur of Benue State Agricultural and Rural Development Authority, Alhaji Danjuma Mohammed of Nasarawa State Agricultural Development Programme, Mr. Jiki Andokari Gede and Mr. Bulus Burba of Taraba State Agricultural Development Programme, Wukari Division, Mr. Edward Bala Kaduna of Taraba State Agricultural Development Programme, Gassol LGA Division.

REFERENCES

1. Alfa-Nla, M.B.A., 2014. Economic analysis of watermelon (*Citrullus lanatus*) production in selected local government areas of Kano State, Nigeria. M.Sc. Thesis, Department of Agricultural Economics and Rural Sociology, Ahmadu Bello University, Zaria, Nigeria.
2. Bohm, V., N.L. Puspitasari-Nienaber, M.G. Ferruzzi and S.J. Schwartz, 2002. Trolox equivalent antioxidant capacity of different geometrical isomers of α-carotene, β-carotene, lycopene and zeaxanthin. J. Agric. Food Chem., 50: 221-226.
3. Isibor, A.C. and C.O.A. Ugwumba, 2014. Analysis of watermelon (*Citrullus lanatus*) marketing in Nnewi metropolis of Anambra State, Nigeria. J. Sci. Multidisciplin. Res., 6: 1-8.
4. Odinwa, B.A., B.I. Isife and C.O. Albert, 2015. Analysis of the adoption rates of watermelon enterprise in Ogba/Egbema/Ndoni local government area of Rivers State, Nigeria. Singaporean J. Bus. Econ. Manage. Stud., 4: 20-28.
5. Akintoye, H.A., A.A. Kintomo and A.A. Adekunle, 2009. Yield and fruit quality of watermelon in response to plant population. Int. J. Veg. Sci., 15: 369-380.
6. Enujeke, E.C., 2013. An assessment of some growth and yield indices of six varieties of watermelon (*Citrullus lanatus* Thumb) in Asaba area of Delta State, Nigeria. Int. Res. J. Agric. Sci. Soil Sci., 3: 376-382.
7. Sabo, M.U., M.A. Wailare, M. Aliyu, S. Jari and Y.M. Shuaibu, 2013. Effect of NPK fertilizer and spacing on growth and yield of watermelon (*Citrillus lanatus* L.) in Kaltungo local government area of Gombe State, Nigeria. Scholarly J. Agric. Sci., 3: 325-330.
8. Adeoye, I.B., O.A. Denton, M.O. Oladapo, O.O. Olufunmi, B.N. Okafor and T. Ajetunmobi, 2007. Consumer preference and awareness for some exotic vegetables in Ibadan, Oyo State. Proceedings of the 25th Annual Conference of Horticultural Society of Nigeria, November 4-8, 2007, Ibadan, Nigeria, pp: 228-233.
9. Ajewole, O.C., 2015. Income and factor analysis of watermelon production in Ekiti State, Nigeria. J. Econ. Sustain. Dev., 6: 67-72.
10. Ibrahim, U.W., A.S.S. Umar and B. Ahmed, 2014. Technical efficiency and its determinants in water melon production in Borno State, Nigeria. J. Econ. Sustain. Dev., 5: 205-211.
11. Olayide, S.O. and E.O. Heady, 1982. Introduction to Agricultural Production Economics, Ibadan. University of Ibadan Press, Nigeria.
12. Abderrahmane, K. and E.W. Lahcen, 2015. Insecticide effect of plant extracts on aphids of watermelon. J. Biol. Agric. Healthcare, 5: 173-179.
13. Chambers, R., 1997. Whose Reality Counts?: Putting the First Last. 2nd Edn., Intermediate Technology Publications, London, UK., ISBN-13: 9781853393860, Pages: 297.
14. Lima, C.H.O., R.A. Sarmento, J.F. Rosado, M.C.A.C. Silveira and G.R. Santos *et al*., 2014. Efficiency and economic feasibility of pest control systems in watermelon cropping. J. Econ. Entomol., 107: 1118-1126.
15. Abate, T., A. van Huis and J.K.O. Ampofo, 2000. Pest management strategies in traditional agriculture: An African perspective. Annu. Rev. Entomol., 45: 631-659.
16. Bentley, J.W., 1992. The epistemiology of plant protection: Hondurancampesino knowledge of pests and natural enemies. Proceedings of the CTA/NRI Seminar on Crop Protection for Resource-Poor Farmers, November 4-8, 1991, University of Sussex, UK., pp: 107-118.
17. Adeoye, I.B., F.B. Olajide-Taiwo, O. Adebisi-Adelani, J.M. Usman and M.A. Badmus, 2011. Economic analysis of watermelon based production system in Oyo State, Nigeria. ARPN J. Agric. Biol. Sci., 6: 53-59.
18. Ajewole, O.C. and J.A. Folayan, 2008. Stochastic frontier analysis of technical efficiency in dry season leaf vegetable production among smallholders in Ekiti State, Nigeria. Agric. J., 3: 252-257.

19. Ampofo, J.K.O., 1997. Utilizing host plant resistance in Integrated Pest Management (IPM) systems for small-scale farmers in Africa. Proceedings of the CTA/IAR/IIRC Seminar on Integrating Biological Control and Host Plant Resistance, October 9-14, 1995, Addis Ababa, Ethiopia, pp: 38-45.
20. Nyeko, P., G. Edwards-Jones, R.K. Day and T. Raussen, 2002. Farmers' knowledge and perceptions of pests in agroforestry with particular reference to *Alnus* species in Kabale district, Uganda. Crop Protect., 21: 929-941.
21. Rogers, E.M., 2003. Diffusion of Innovations. 5th Edn., Simon and Schuster, New York, USA., ISBN-13: 9780743258234, Pages: 576.
22. Tefera, T., 2004. Farmers' perceptions of sorghum stem-borer and farm management practices in Eastern Ethiopia. Int. J. Pest Manage., 50: 35-40.
23. Benjamin, B.K., B.M. Kelvin, A.N. Kwame and O.O. Daniel, 2012. Farmers' knowledge and perceptions of fruit fly pests and their management in Northern Ghana. Greener J. Agric. Sci., 2: 412-423.
24. Olaniran, O.A., S.A. Babarinde, A.F. Odewole, P.A. Aremu and K. Popoola, 2014. Rural farmers' perceptions, knowledge and management of insect pests of fruit vegetables in Ogbomoso agricultural zone of Nigeria. Int. Lett. Nat. Sci., 25: 18-28.
25. Nantoume, A.D., S. Traore, J.L. Christiansen, S. Bode and B.D. Jensen, 2012. Traditional uses and cultivation of indigenous watermelons (*Citrullus lanatus*) in Mali. Int. J. Biodivers. Conserv., 4: 461-471.
26. Sales, M.A.F., M.B. Lacerda, B.L.D. Horn, I.A.P. de Oliveira and C.L. Schultz, 2016. The "χ" of the matter: Testing the relationship between paleoenvironments and three theropod clades. PLoS ONE, Vol. 11. 10.1371/journal.pone.0147031.
27. Adewuyi, S.A. and F.Y. Okunmadewa, 2001. Economic efficiency of crop farmers in Kwara State, Nigeria. Niger. Agric. Dev. Stud., 2: 45-57.
28. Alene, A.D. and R.M. Hassan, 2003. The determinants of farm-level technical efficiency among adopters of improved maize production technology in Western Ethiopia. Agrekon, 42: 1-14.
29. Banjo, A.D., O.A. Lawal, O.E. Fapojuwo and E.A. Songonuga, 2003. Farmers' knowledge and perception of horticultural insect pest problems in Southwestern Nigeria. Afr. J. Biotechnol., 2: 434-437.
30. Yusuf, S.F.G., F.S. Lategan and I.A. Ayinde, 2013. Profitability and adoption of watermelon technologies by farmers in Moro local government of Kwara State, Nigeria. J. Agric. Sci., 5: 91-99.
31. Nyukuri, E., 2006. Women, Land and Resource Conflicts: Policy Implications and Interventions in Kenya. African Centre for Technology Studies Press, Nairobi, Kenya, ISBN: 9966-41-140-2, Pages: 50.
32. Paradza, G.G., 2011. Innovations for securing women's access to land in East Africa. Working Paper No. 13, International Land Coalition, Rome, Italy, March 2011, pp: 1-15.
33. United Nations, 2012. Challenges and barriers to women's entitlement to land in India. United Nations Entity for Gender Equality and the Empowerment of Women Asia and the Pacific, LANDESA/Rural Development Institute, India, pp: 1-28.
34. Okonya, J.S., R.O. Mwanga, K. Syndikus and J. Kroschel, 2014. Insect pests of sweetpotato in Uganda: Farmers' perceptions of their importance and control practices. SpringerPlus, Vol. 3. 10.1186/2193-1801-3-303.
35. Adenegan, K.O., O. Adams and L.O.E. Nwauwa, 2013. Gender impacts of small-scale farm households on agricultural commercialisation in Oyo State, Nigeria. Br. J. Econ. Manage. Trade, 3: 1-11.
36. Oladoja, M.A., B.O. Adisa and A.A. Ahmed-Akinola, 2006. Effectiveness of communication methods used in information delivery to cocoa farmers in Oluyole local government area of Oyo State. Ogun J. Agric. Sci., 4: 78-88.
37. Amaza, P.S. and J.K. Olayemi, 2000. The influence of education and extension contact on food crop production in Gombe State, Nigeria. J. Agribus. Rural Dev., 1: 80-92.
38. Kehinde, L.K., 2005. Efficiency of sawn wood production and distribution in Ondo State, Nigeria. Ph.D. Thesis, Department of Agricultural Economics, University of Ibadan, Ibadan, Nigeria.
39. Madisa, M.E., Y. Assefa and M. Obopile, 2010. Assessment of production constraints, crop and pest management practices in peri-urban vegetable farms in Botswana. Egypt. Acad. J. Biol. Sci., 1: 1-11.
40. Chamo, A.M., B.B. Sabo, A.K. Karaye and A.M. Rabiu, 2016. Factors affecting watermelon (*Citrullus vulgaris*) production among farmers off Gada Community, Kazaure local government area, Jigawa State. Global Adv. J. Agric. Sci., 5: 432-439.
41. Fatondji, D., D. Pasternak and L. Woltering, 2008. Watermelon production on stored rainwater in Sahelian sandy soils. Afr. J. Plant Sci., 2: 151-160.
42. Alghali, A.M., 1991. Studies on cowpea farming practices in Nigeria, with emphasis on insect pest control. Trop. Pest Manage., 37: 71-74.
43. Alao, F.O., T.A. Adebayo and O.A. Olaniran, 2016. Population density of insect pests associated with watermelon (*Citrullus lanatus* Thumb.) in Southern Guinea Savanna zone, Ogbomoso. J. Entomol. Zool. Stud., 4: 257-260.
44. Ogunlana, M.O., 1996. Insect pests of watermelon *Citrullus lanatus* in Samaru, Zaria. Research Programmes Reports (1995-1996), Institute of Agricultural Research, Ahmadu Bello University, Zaria, Nigeria, pp: 171-172.
45. Bamaiyi, L.J., S.E.L. Alao and E. Amans, 2010. Optimum sprays required for insect pests management on rainfed watermelon. Horticultural Crop Research Programme, Cropping Scheme Reports, Institute of Agricultural Research, Ahmadu Bello University, Zaria, Nigeria, pp: 33-35.

46. Webb, S.E., 2013. Insect management for cucurbits (cucumber, squash, cantaloupe and watermelon). Institute of Food and Agricultural Sciences Extension Publication No. ENY-460, University of Florida, USA., pp: 1-18.
47. Gentry, J.W., 1965. Crop Insects of Northeast Africa-Southwest Asia. Agriculture Handbook No. 273, Agricultural Research Service, United States Department of Agriculture, Washington, DC., USA., Pages: 210.
48. Engel, L.S., D.A. Hill, J.A. Hoppin, J.H. Lubin and C.F. Lynch *et al*., 2005. Pesticide use and breast cancer risk among farmers' wives in the agricultural health study. Am. J. Epidemiol., 161: 121-135.
49. Naidoo, S., L. London, A. Burdorf, R.N. Naidoo and H. Kromhout, 2008. Agricultural activities, pesticide use and occupational hazards among women working in small scale farming in Northern KwaZulu-Natal, South Africa. Int. J. Occup. Environ. Health, 14: 218-224.
50. Denkyirah, E.K., E.D. Okoffo, D.T. Adu, A.A. Aziz, A. Ofori and E.K. Denkyirah, 2016. Modeling Ghanaian cocoa farmers' decision to use pesticide and frequency of application: The case of Brong Ahafo region. SpringerPlus, Vol. 5. 10.1186/s40064-016-2779-z.
51. Mahmud, M.M., J.C. Akan, Z. Mohammed and N. Battah, 2015. Assessment of organophosphorus and pyrethroid pesticide residues in watermelon (*Citrullus lanatus*) and soil samples from Gashua, bade local government area Yobe State, Nigeria. J. Environ. Pollut. Hum. Health, 3: 52-61.
52. Akan, J.C., M.M. Mahmud, M. Waziri and Z. Mohammed, 2015. Residues of organochlorine pesticides in watermelon (*Citrullus lanatus*) and soil samples from Gashua, Bade local government area Yobe State, Nigeria. Adv. Anal. Chem., 5: 61-68.
53. Souza, C.R., R.A. Sarmento, M. Venzon, E.C. Barros, G.R. dos Santos and C.C. Chaves, 2012. Impact of insecticides on non-target arthropods in watermelon crop. Semina: Ciencias Agrarias, 33: 1789-1801.