A Survey of the Insect Pests and Farmers' Practices in the Cropping of Tomato in Nigeria

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Summary

A survey of some tomato producing areas of Nigeria indicated that the major insects attacking tomato included the fruit borer Helicoverpa armigera *Hübner, the grasshopper* Zonocerus variegatus *L., the whitefly* Bemisia tabacci *Gennadius, and various species of aphids, mostly* Aphis gossypii *Glover. Interviews conducted to assess farmers' practices which contribute to insect damage showed that inappropriate application of insecticides and the use of wrong dosages may have contributed to insect control failures. Intercropping tomato with crops such as cereals tubers and other vegetables reduced infestation in some areas. However, most farmers' practices did not affect insect pest abundance. Insect populations and percentages of infestation were, in most cases, found to be significantly higher in Oyo state (in the rain forest agro-ecological zone) than in other surveyed states located in the savannah agro-ecological zones.*

Résumé

Enquête sur les insectes nuisibles et sur les techniques culturales de la tomate au Nigeria

Une enquête effectuée dans des zones productrices de la tomate au Nigeria a indiqué que parmi les insectes ravageurs de cette plante figurent les rongeurs de fruits Helicoverpa armigera *Hübner, les sauterelles* Zonocerus variegatus *L., les mouches blanches* Bemissia tabacci *Genadius ainsi que diverses espèces de pucerons dont la plupart est* Aphis gossypii *Glover. Les enquêtes réalisées chez les fermiers ont montré que certaines mauvaises techniques culturales sont à la base des dégâts causés par les insectes. Il s'agit d'une application inappropriée d'insecticides ainsi qu'un mauvais dosage d'insecticide. Il a été constaté que l'infestation était réduite dans des champs où la tomate était associée avec les céréales, les tubercules ou avec d'autres légumes. Néanmoins, la plupart des techniques culturales n'avaient pas de rapport avec l'effectif d'insectes nuisibles. Cette étude montre que les populations d'insectes ainsi que les pourcentages d'infestations sont significativement plus élevés dans l'état d'Oya (zone forestière) par rapport aux autres états situés dans les zones savanières.*

Introduction

Tomato, *Lycopersicon lycopersicon* L. Kast (= *Lycopersicon esculentum* Mill.) is a fruit vegetable consumed extensively in Nigeria. Its production spreads all over the country. However, the major producing areas lie between latitudes 7.5 °N and 13 °N, and within a temperature range of 25 – 34 °C (11). The areas include most states in northern Nigeria such as Bauchi, Benue, Borno, Kaduna, Kano, Plateau, Sokoto, and some southern states which include Delta, Kwara and Oyo (3). Tomato production in Nigeria has been facing many biotic and environmental constraints. Prominent among such constraints are pests and diseases which reduce yields and the quality of marketable fruits. In the tropics, particularly in Nigeria, many insect pests are associated directly with tomato damage and yield losses while some others are most important as vectors of diseases (1, 6, 8, 10).

A survey was therefore conducted by the National Horticultural Research Institute in some major producing areas to assess the state of the art in tomato production with a view to identifying production problems related to insect pests that require research attention.

The findings presented in this report are those on insect pests of economic importance to tomato. The survey had the objective of (i) identifying, through questionnaires, technologies applied by farmers and their cultural practices which influence insect spread and damage, and; (ii) identify through field sampling major tomato insect pests and their spread.

Material and methods

The survey was conducted in 120 tomato farms located in five major producing states of Bauchi (now

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split into Bauchi and Gombe states), Kaduna, Kano, Oyo and Plateau in the 1995 cropping season (Figure 1).

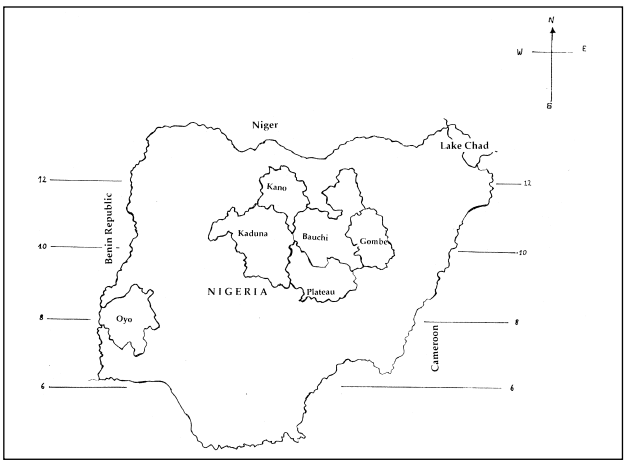

Figure 1: Map of Nigeria showing the surveyed states.

The choice of the states, zones and localities (consisting of villages) visited was based on the following: (a) relative importance of tomato in the crops grown in the state, (b) its level of production and (c) agro-climatic zone. Oyo state is in the rain forest belt with its northern part in the southern Guinea savannah agro-ecological zone. The average annual rainfall of the latter is 2000 mm, and tomato cultivation is rain-fed or with residual moisture. Parts of Plateau state consist of rocky terrain (plateau) with high elevation, and has lowest temperature records in Nigeria (often< 24 °C) during the dry season, with an average annual rainfall of about 1200 mm. Beside Kano state which is in the Sudan savannah zone with an average annual rainfall of 800 mm, Bauchi and Kaduna states are in the northern Guinea savannah zones and receive about 1100 mm mean annual rainfall. Apart from Oyo state where tomato is grown in the rainy season, cultivation in the other states is at the onset of the dry season with residual moisture or irrigation. Insect pests were sampled in farmers' plots between June and July in Oyo state, and in December in the other states using a stratified random sampling methods. A total of 40 plants were sampled from fields less than 1500 m^2, while 80 samples were taken from those = 2500 m^2. Observations were made *in situ* on the leaves, fruits and stems for insect damage. Since the farmers did not allow the removal of apparently healthy plants, only the roots of dead plants were observed for insect damage. Insects samples were identified in the field and in the laboratory at the National Horticultural Research Institute. Farmers owning the sampled farms were interviewed on the cultural practices that were likely to influence insect damage. The practices include: the cropping systems practised, method of land preparation, maintenance of bush fallow system and pest control methods. Percentages of plants damaged by insects per farm were grouped and rated 0 - 6 at an interval of 15% damage, with 6 being the highest level, and correlated with relevant quantifiable survey variables such as the number of years a farm was kept under fallow, the number of times a farm was treated against pests per cropping season, the number of intercropping species found in the field. T-test analyses were used to compare insect pest populations between states. Parameters assessed through questionnaires were expressed in percentages of responses obtained.

Results

Farmers' responses on farm cultural practices and observations from field sampling

The major occupation of the 120 interviewed farmers was farming. Only about 30% were involved in some off-farm activities to supplement income generated from farming. Majority of the farmers derived more than 50% of their income from tomato production. While the farmers' cultivated tomato plots ranged between 0.2 and 6 ha in the areas surveyed, only about 40% of the farmers cultivated more than 1 ha of land at a time. Farmers preferred to rotate tomato with other crops such as cereals, tubers and other vegetables but seldom practise bush fallow system due to the scarcity of cultivable land. Only 25% of farmers in the surveyed areas practised bush fallow system which they claimed had no effect on insect infestation. Land clearing prior to tillage consisted of slashing and burning, clearing and leaving the residues to decay *in situ*, or by direct burning of vegetation without cutting or using tractor to plough the land. Farmers did not experience any effects on insect pest damage by these methods of clearing. Crops intercropped or relayed with tomato include lettuce *Lactuca sativa* L., cabbage *Brassica oleracea* L., pea *Pisum sativum* L., carrot *Daucus carota* L., onion *Allium cepa* L. and peppers *Capsicum* spp. in the northern states, while in Oyo state in the south, the crops are okra *Albelmoschus esculentus* (L.) Moench, peppers, amaranths *Amaranthus* spp., *Celosia* spp., *Corchorus* spp., maize *Zea mays* L., cassava *Manihot esculenta* Crantz and yam *Dioscorea rotundata* Poir (Table 1).

Multiple cropping was observed in 60% of the surveyed farms. However, 42% of the farmers who intercropped tomato in Oyo state affirmed that they sometimes practise monocropping. More than 50% of farmers in Bauchi, Kaduna and Plateau states practised multiple cropping, while 90% monocropped tomato in Kano. Responses from 55% and 65% of farmers in Oyo and Kaduna states respectively indicated that intercropping reduce pest damage on tomato. Farmers from other states do not share this view. The varieties of tomato planted by the farmers vary considerably across localities (Table 1) depending on adaptability to local conditions. The percentages of insect attack reported by farmers varied across the states (Table 1). Ninety percent of the farmers reported higher insect attack at plant maturity compared to early growth stages of tomato. Majority (76%) of these farmers initiated various methods of control against insect pests. Among these farmers, 41% controlled insect pests by applying synthetic

Table 1

Farmers' responses to questionnaires, and field observations on tomato insect pests in major producing areas of Nigeria

States and Local Government Areas (LGA)	Varieties cultivated in the LGA	*Crops interplanted with tomato	*Predominant insect pests	Plants attacked (mean %)	Control methods in the LGA
Bauchi state		Pepper, onion, lettuce, carrot,	Aphids, *Helicoverpa*		
Deba	2, 7, 9, 10, 11, 12, 13	cabagge	*armigera,*	21	CH, NC
Durun	2, 7, 9, 10, 11, 12, 13, 14		white flies	13	CH
Ningi	2, 7, 9, 10, 11, 12, 13, 14			46	CH, CC
Kaduna state		Pepper, onion, carrot, cabagge	Aphids, *H. armigera*		
	2, 7, 9, 10, 11			62	CH, CC
Birnin	2, 7, 9, 10, 11			26	CC, NC
Gwari	2, 7, 8, 9, 10, 11			36	CC, NC
Kaura	2, 7, 8, 9, 10, 11, 12, 13			48	CH, CC
Ikara					
Zango Kattaf					
Kano state		Onion, carrot, pepper,	Aphids, *H. armigera*		
Kura	2, 8, 9, 10	cabbage		20	CH, NC,
Dambatta	2, 7, 8, 9, 10, 11			29	CH
Wudil	2, 8, 11			36	CH, CC
Plateau state		Lettuce, pepper,	Aphids, *H. armigera*		
	2, 7, 8, 9, 10, 11, 12	cabbage,		12	CH, CC, NC
Jos South	10, 11, 12	green pea		37	CH, NC
Birnin Ladi	2, 10, 11, 12			8	NC
Mangu	2			18	CC, NC
Panshin	2			27	CH
Wase	2			40	CH
Keffi					
Oyo state		Okra, pepper, amaranths,	Aphids, grasshoppers,		
Ifedapo	1, 2	*Celosia* spp.,	crickets,	41	CH, NC
Orelope	1, 3	*Corchorus* spp.,	leaf miners,	43	CH, CC
Irepo	1, 3	maize,	white flies,	42	CH, CC
Orire	1, 3, 4	cassava, yam	*H. armigera*,	38	NC
Kajola	1, 2, 3, 4		*Spodoptera*	49	CH, CC, NC
Ogo-Oluwa	3, 4, 5		*littoralis*	65	CH
Surulele	1, 4			32	CC
Ido	3, 4, 5			10	CH
Ibarapa	1, 6			36	CC, NC

1= Ibadan local; 2= Roma; 3= Alara; 4= Omowere; 5= Omoko; 6= Ojutonsoro; 7= Tandino; 8= Harvester; 9= UTC; 10= UC; 11= Ronita; 12= Dansiria; 13= Rukuta; 14= Sawunkura; CH= Chemical control; CC= Cultural control; NC= No control; *Field observations.

pesticides, 8.4% used cultural methods such as roguing and application of wood ash, while 50% applied both synthetic pesticides and cultural control. The insecticides used namely gamma-BHC, DDT etc., were inappropriate or applied at wrong dosages for the identified pests. Of the interviewed farmers 77% did not obtain any satisfactory results from their control methods while others could not discern whether their control methods were successful. The major insect pests observed during field sampling included the grasshopper *Zonocerus variegatus* (defoliators), the tomato fruit borer *Helicoverpa armigera*, white fly *Bemissia tabacci*, aphids *A. gossypii* (most occurring) and *Myzus persica* Sulzer. The white flies and aphids are most important as vectors of viral diseases. The incidence of mole crickets *Gryllotalpa* spp., which severed tomato plants at the base, was sporadic and limited to Oyo and plateau states. The occurrence of the leaf miner *Liriomyza trifolii* Burgess which made serpentine tunnels on leaves was mostly limited to Oyo state.

White fly mean population per plant varied from one to two in Oyo and Bauchi states. No occurrences were recorded in other states. A significantly higher mean population of Z. *variegatus* per plant was observed in Oyo state compared to Bauchi, Kaduna and Kano states (t= 3.5; df= 38; P< 0.001) (Table 2) which had approximately the same mean population (Figure 2).

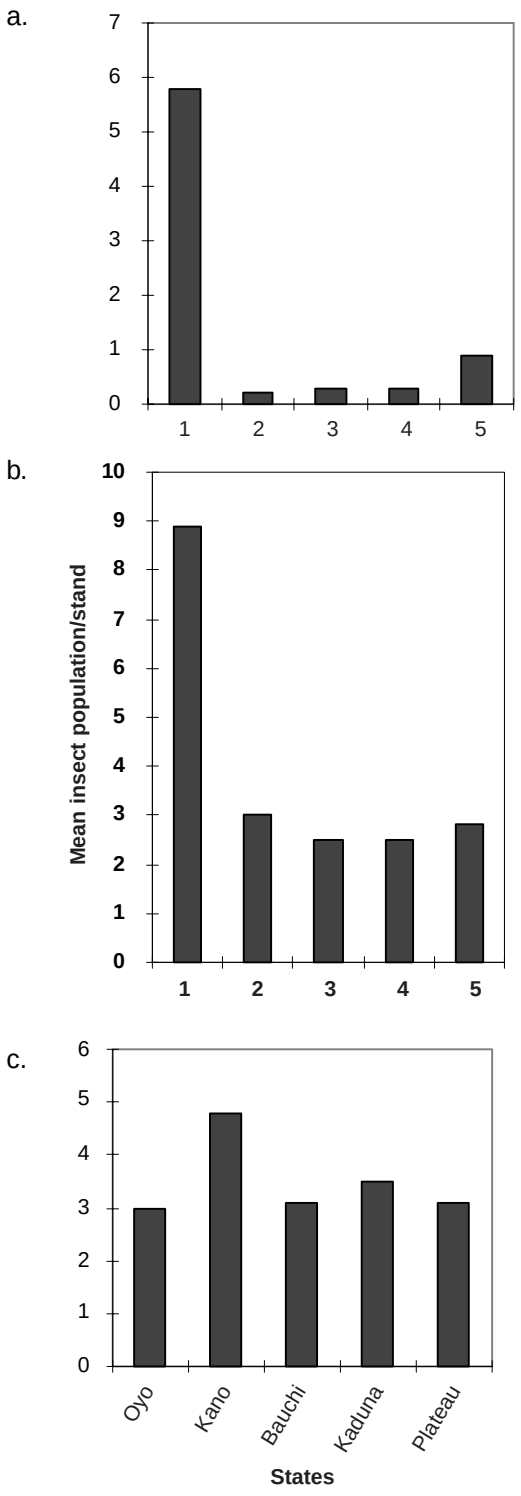

Figure 2: Population of insect pests in field tomato in five producing states of Nigeria. (a) *Zonocerus variegatus* (b) *Helicoverpa armigera* (c) *Aphis gossypii*.

Similar significantly higher population of Z. *variegatus* was observed in Oyo compared to plateau (t= 2.08; df= 38; P< 0.05). *Zonocerus variegatus* populations were not significantly different (P> 0.05) between Bauchi, Kaduna, Kano and Plateau states. The mean populations of aphids *A. gossypii* per plant ranged from 3.0 to 4.8, with no significant differences between the states. Fruit infestation by the fruit borer *H. armigera* was predominant. *Spodoptera littoralis* (a defoliator) was only observed in about 8% of the total samples. The mean population of *H. armigera* per plant was significantly higher (P< 0.01; df= 38) in Oyo state (8.9) compared to 2.5 in Bauchi, 3.0 in Kaduna and Kano and 2.8 in Plateau with t= 2.67, 2.56 and 2.62 respectively (Table 2).

Table 2

T-test analyses for differences between the populations of major tomato pests in the surveyed states in Nigeria

Insect species	t-test values (other states compared with Oyo)$^{\gamma}$			
	Kano	Bauchi	Plateau	Kaduna
Zonocerus variegatus	3.5***	3.5***	2.08*	3.5***
Aphis gossypii	NS	NS	NS	NS
Helicoverpa armigera	2.5**	2.67**	2.62**	2.67**

* P< 0.05; ** P< 0.01; *** P< 0.001; NS= Not significant; $^{\gamma}$Degree of freedom (df)= 38

The mean percentages of plants infested by *Z. variegatus* and by the tomato fruit borers per farm were higher in Oyo state compared to the mean values in other states with only fruit borer infestation in Oyo being significantly (P< 0.01) higher (Figure 3).

The percentage infestation of tomato by aphids was significantly lower in Oyo compared to Bauchi, Kaduna, Kano and Plateau states. There were no significant differences between the percentages of infested tomato in these four states. Relatively higher mean percentage (12%) infestation of tomato by leaf miners was recorded in Oyo state compared to other states where infestation was very low or non-existent. Pathogens which may have contributed to tomato stand and yield losses in the survey included *Fusarium*, *Alternaria*, *Stemphylum* and *Erwinia* species, while the parasitic nematodes included *Meloidogyne* and *Practylenchus* species. Viral diseases such as tobacco mosaic virus, cucumber mosaic virus and tomato leaf curl virus were also identified on tomato.

Relationship between some farmers' cultural practices and insect damage on tomato

Regression analyses showed that most of the farmers' cultural practices such as the number of years a field

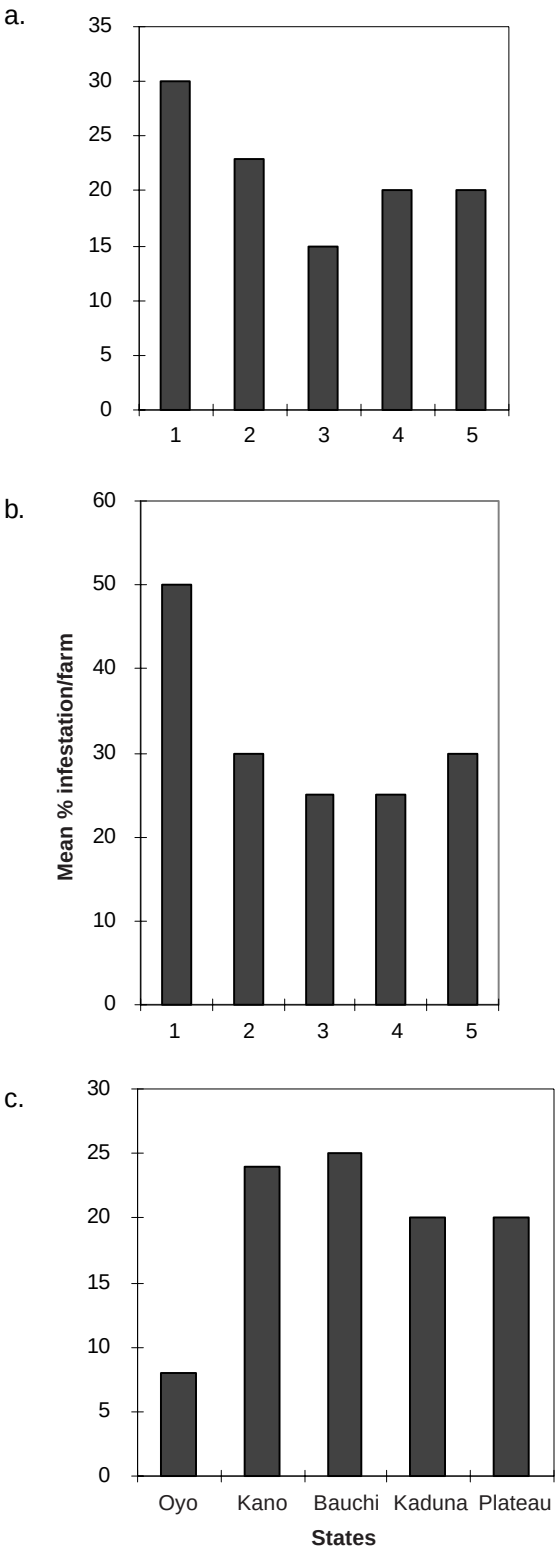

Figure 3: Percentage of tomato plants infested by insect pests in five producing states of Nigeria. (a) *Zonocerus variegatus* (b) *Helicoverpa armigera* (c) *Aphis gossypii.*

was kept fallow or given treatments against pests did not influence the level of insect damage. Only observations made in farms in Oyo and Kaduna states were used to assess the effect of the number of plant species intercropped with tomato on insect damage because both monocropping and intercropping involving various plant species were practised in these two states. The levels of damaged tomato significantly decreased with increase in the number of plant species in the intercrop in Oyo ($r= -0.731$; $P< 0.03$; $df= 19$) and Kaduna ($r= -0.637$; $P< 0.002$; $df= 19$).

Discussions

In Oyo and Kaduna states where intercropping tomato with other crops is predominantly practised, majority of farmers reported that the practice has advantages to reduce insect pests. Our regression analyses showed that there was a significant decrease in tomato infestation with increase in the number of plant species intercropped with tomato ($r= -0.731$). This advantage may have been derived from the companion crops acting as barrier or camouflage against insects, or masking the host's attractants thereby distorting the orientation and host seeking behaviour of the insect pests (4, 5, 7, 9). Farmers responses indicated that the methods of land preparation for tomato did not influence insect infestation. Similarly, regression analyses of damage versus some farmers' cultural practices also showed no influence on insect pest damage. The higher pest infestation at plant maturity indicated by the farmers may be associated with the period of attack of the insects most familiar to them; an example is the fruit boring *H. armigera* that is quite known to them as being most damaging at fruit formation than at early vegetative stage. Farmers' insecticide applications did not reduce pest problems as insecticides and dosages appropriate for the control of the identified insects were seldom utilised. Furthermore, cultural practices such as staking that reduce diseases and fruit borer damage (10) were not applied by the farmers. The higher incidence of insect pests in Oyo state in the south may be attributed to its relatively higher humidity (due to the rainy season) which supports the multiplication of pests and diseases, and vegetation diversity associated with humid zones (including various off-season alternative hosts of the pests' developmental stages) compared to the other states located in the savannah agro-ecology. These favourable conditions may have contributed to the increased population of insects such as *Zonocerus variegatus*, *Helicoverpa armigera* and the leaf miner *L. trifolii* in Oyo state. The survey showed that tomato production is likely to be less prone to insect pest attack in the northern than the southern parts of Nigeria probably due to periods of cultivation. Therefore to increase tomato production in southern Nigeria, research efforts should be geared towards the development of high-yielding and pest/disease resistant varieties adapted to the southern agro-ecological zones as well as promoting the cultivation of dry season tomato. Extension methods should be improved to ensure adoption of new agricultural technologies by farmers in the entire country. Since, it has been reported that despite the technologies already transferred to farmers on tomato production, signifi-

cant shortfalls are still experienced (2). The survey also showed that intercropping tomato with other plant species as practised by farmers reduced insect pest damage. This emphasises the need to develop integrated pest management strategies that should include some desirable farmers' practices in order for them to be acceptable to small holders.

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