

Effects of Chemical Constituents on Insect Pest Population in West African Okra, *Abelmoschus*

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Abstract: A study was carried out on the effects of chemical constituents on insect pest attack on genotypes in West African Okra, *Abelmoschus caillei*. The growth and yield response of the genotypes to pest infestation was determined. The biochemical analysis was carried out using the seeds of the genotypes to determine the bioactive ingredients content. Field experiment was laid out in Randomized Complete Block Design (RCBD) with four replications. The result indicated that three of the genotypes, (CEN 010, , NGAE-96-0123 and NGAE-96-0067) attracted less number of insects, recorded lower percentage of leaf damage (27.19%, 27.41% and 31.73%) and percentage pod damage (22.06%, 35.68% and 40.46%) and recorded higher level of harmful bioactive ingredients which conferred resistance to insect attack compared to the susceptible ones. The result of correlation analysis carried out between seed yield and the other traits show that a significant and positive exists between number of fruits per plant and number of damaged pods; number of insect feeding holes and number of *Podagrica* spp.; number of damaged pods and number of *Dysdercus supersticiosus*. A negative correlation also exists between number of damaged leaves, number of *Dysdercus supersticiosus*, number of insect feeding holes, number of *Podagrica* spp. and seed yield. From the study, it can be concluded that antixenosis was the basis of resistance to insect attack. Three of the genotypes (NGAE- 96-0067, NGAE-96-123 and CEN 010) used in this study are therefore recommended to farmers because of their economic value inspite of insect attack.

Key word: *Abelmoschus caillei*, chemical constituents, insect population, *Dysdercus supersticiosus*, *Podagrica* spp., Genotypes.

I. Introduction

West African okra, *Abelmoschus caillei* [A.chev] Stevels belongs to the family malvaceae. It is found throughout the high rainfall zones and is mainly grown for subsistence. Stevels (1988) described West African okra as a separate specie based on observation in Cameroon and on work carried out by Siemonsma in Cote d'Ivoire between 1977 and 1980. *A. caillei* is mainly found in the humid coastal zones of west and central African and more sparingly in its savannah belt. It is much more abundant in the North of the Equator than the South of it. It is commonly found around homes and along roads (Ariyo, 1993) but rarely in undisturbed forests.

It is much appreciated because it continues fruiting during dry season when few other vegetables can be found thus providing the farmers with addition income. In contrast, the common okra, *Abelmoschus esculentus* [L] Moench fruits only during the rainy season or under irrigation. West African okra remains green during the period of drought, thus allowing people to eat its young leaves when needed. Since the identification of *A. caillei* as a second cultivated okra crop in Africa, there had been several germplasm collecting missions and the characteristic of the new specie is still being studied in detail. *A. caillei* is a multipurpose crop valued for its tender and delicious pods which are bigger than the pods of *A. esculentus* (L) Moench.

Furthermore, the tender pods of okra at edible stage contains 88ml H₂O, 2.1g protein, 0.2g fat, 175.2mg minerals and 232.72mg vitamin in 100g of edible portion; the edible leaves contain about 81ml H₂O, 56 calories of energy, 11g carbohydrate, 4.4 protein, 0.6 fat, 2.1 fibre, 602.7mg mineral and 44.72mg vitamin per 100g (FAO, 1972).As common to other crops, pest infestation on vegetables has negative effect on their yields. Over the year, pesticides have been used to control insect attack but this has always resulted in increased cost of production and sometimes having residual effect on the environments. Breeding programs that confer resistance to pest attack is needful in order to ensure food security. Plants show the resistance mechanism that deter the prevalent insects pests from inflicting on them any form of injury. Such resistance includes: Non-Preference (antixenosis) in which normal behavior is impaired to reduce chances of injury by pest specie. There is also the presence of morphological factors which affects the insects' penetration and such structure include: trichomes, glandular hair, gummy exudates, pubescence, tissue toughness or hardness.

II. Insects Pest Of Okra And Their Economic Importance

Yield of agricultural crops is often reduced below its potential because of pests and diseases. The control of these pests invariably results in increase yield but also increase in cost of production. It is often

observed that most insecticides used in controlling pest population are not effective in totally eliminating the pest because additional pest may immigrate after application and some of the pest may even survive pesticide application. Thus, one practical means of achieving greater yields is to minimize the pest associated losses which are estimated at 14% of the total agricultural production. (Oerke et al, 1994).

Each crop has its own peculiar pest limiting its productivity. Insect pests not only cause direct loss to the agriculture products but also indirectly as vectors of various plant pathogens. Pests associated losses have been reported to be 52% in wheat, 83% in rice, 59% in maize, 74% in potato, 58% in soybean and 84% in cotton (Oerke et al, 1994).

Vegetable production which is an important source of income for many small scale farmers in African is also subjected to economic loss by insects pests. One major constraint in vegetable production is the effective prevention and control of pests and disease which causes high yield losses (Tindall, 1983). Vegetable losses due to pests can be as high as 25% which can result in severe income loss to small scale farmers. Avoidable losses in okra particularly due to pest have been placed at about 54% (Chaudhary and Deedhack, 1989). Vegetable are attacked by large number of insect pest which ultimately lead to reduction in both quality and yield.

The pests limiting vegetables production are classified into the following broad categories: sapsucker, leaf eaters, leaf and fruit borers, leaf rollers, flower feeders and leaf miners.

Among the sapsuckers are the nymphs and adults of cotton aphid, *Aphis gossypii* which infest the plant by killing developing plant cells. Severally infested plant results in leaf distortion, curling and yellowing of leaves, stunted and retarded growth and failure to set bloom. It also acts as vector of viral disease (Tindall, 1983). Whiteflies, *Bemisia tabaci* (the adult lays eggs on the underside of the leaves and infested leaves become discolored and fall off from the plant). It also secret honeydew on plants which allow unsightly black sooty mould to grow resulting in reduced leaf area for photosynthesis. Severally infested plants have stunted and retarded growth and development. Green leaf hoppers, *Empoasca spp.* (feed on apices of young plant resulting in stunted and retarded growth, they also inhibit food translocation by destroying the tissues responsible for translocation (Hill, 1983); other include cotton stainers, *Dysdercus supersticiosus* and the cotton seed bug, *Oxycarenus hyalinipennis*.

The leaf eaters include beetles such as: Fleabeetles, *Podagrica spp.* (they make round holes in leaves resulting in death of young plants. In severe infestation the infested plants have retarded and stunted development which result in reduced plant vigor and an ultimate reduction in yield); *Nisotra spp.* (feed on the outer layer of leaves resulting in damage of the cotyledons. Severe infestation results in plant death); spiny boll worms, *Earias spp.* (They damage the young growing plants by boring through the terminal shoots resulting in death of the apical growth and the infested plants have stunted and retarded growth, (Tindall, 1983). *Helicoverpa armigera* (the pest) infest the growing plant by boring circular holes in the developing fruits and flower buds and the buds wither and fall off after being bored into (Hill and waller, 1994)).

The most devastating period of all insects pest is the larvae stage of the pest because the insects is at the growth stage and being highly active and effective, it is at this stage, their level of attack on growing plant has a detrimental effects on the growing plants and thus resulting in low yield. Based on this fact, it is expected that farmers should be able to recognize the insects found on their crops especially the commercial vegetable growers in order to put in place an adequate and effective pest control thus minimizing economic loss arising from reduction in yield.

2.1 Breeding For Insect Resistance

In the past, insecticides were used to combat the problem of pests. Nowadays, quite a number of farmers are still using insecticides but the fact remains that the consequential effects on the total income and returns is great because of the increase in cost of production. Not only this, continuous use of the insecticide has effects on the other beneficial insects and also contamination of the environment (Sun et al, 2000). The indiscriminate use of pesticides has been reported to have led to the destruction of beneficial insects and non-target organisms, accumulation of toxic residues on produce and human poisoning (Kumar and Moorthy, 2001; Harris and Dent, 1999). Similarly, Awasthi (2001) reported that pesticides residues especially in vegetables may create health hazards to the consumers which in turn restrict export market of vegetables.

In recent years entomologists in several countries have stressed the need for developing integrated management strategies for insects control to optimize agricultural production without upsetting the balance of nature since massive application of pesticide result in adverse effects on the beneficial organisms, residual effect on crops and also environmental pollution. This has necessitated the use of target specific compound with low persistence and more emphasis should be based on integrated pest management which is based on host plant resistance to insect pests.

Plant breeders and entomologists should therefore, include insects' resistance as a component of their crop improvement program. With greater collaboration and commitment from plant breeders, biotechnologist and entomologists, crop resistance could play a major role in Integrated Pests' Management (IPM) of insect pest

of crops. In many cases multiple genes are required for sustained resistance to counter pest adaptation, thus maintaining agricultural productivity to enhance world food security.

A thorough knowledge of insects, plants and their interrelationship is required to evaluate cultivar for insects' resistance. Successful breeding for insect and disease resistance has occurred in much type of crops including vegetables, fruits, field crops and ornamentals. Hence, selecting plants variety that has resistance or tolerance to insects or disease makes it possible to avoid or lessen the use of pesticides. When plants are attacked by insects, they defend themselves through a continuum of defensive strategies including direct resistance (chemical or mechanical traits that reduce the impact of the pests); indirect resistance (traits enhancing the action of enemies of the pests) or tolerance (regrowth). The site of production of defensive metabolites is variable in plants, depending on the nature of the compound and the plant species.

Several chemical constituents of plant serve as olfactory and gustatory stimuli for insects. These chemicals may be nutrients in form of sugar, amino-acid, phospholipids etc. or non-nutritive constituents that is, glycosides, alkaloids, terpenoids, etc. The insect may be repelled by plants volatile compounds without coming in contact with plant or having made contact, feeding may be suppressed or having bitten the leaf, the insects may be deterred from further feeding. A number of insects have been reported to be affected by the plant volatile compounds that are specific to their host plant (Visser, 1986). Zehnder (2004) reported that some plants contain organic compounds that act as pest repellents which protect the crops by keeping pests away from them and thus avoiding potential pest damages.

III. Materials And Methods

This research was carried out at the farm centre Federal Polytechnic Ilaro, Ogun State in February 2009. Six genotypes of West African Okra were utilized in this study. They were obtained from the germplasm collection of the National Centre for Genetic Resources and Biotechnology (NACGRAB), Moor Plantation, Ibadan.

Table 1: The Names and Sources of Okra Genotypes

Parent No	Genotype name	Source
P ₁	NGAE-96-0060	National Centre for
P ₅	NGAE-96-0066	Genetic Resources
P ₆	NGAE-96-0067	and Biotechnology (NACGRAB)
P ₈	NGAE-96-0123	
P ₁₁	CEN 10	
P ₁₂	OWOSDE	

The seed were sown in Feb. 2009 in a randomized completes block design using four replications each replicate measures 10m by 7m. A single row plot with an inter row spacing of 1 metre was adopted. The spacing used was 1 meter between rows and 0.6 meter within rows. Two seeds were planted per hole and later thinned to one plant per stand. A maximum of 11 plants were maintained per row. A compound fertilizer of NPK 15:15:15 was applied at the rate of 50kg/ha in two doses, first at 3 weeks after planting and secondly at flowering. Data were recorded on six mid plants of each of the accessions. Weeding of the plot was done on a regular basis from planting to harvesting.

Data were collected on the following :- Number of leaves per plant, Number of damaged leaves per plant, Number of damaged pods per plant, Number of insects per plant, Number of pods per plant, Number of insects feeding holes per plant, Seed yield per plant and biochemical analysis of pods per plant.

IV. Results And Discussion

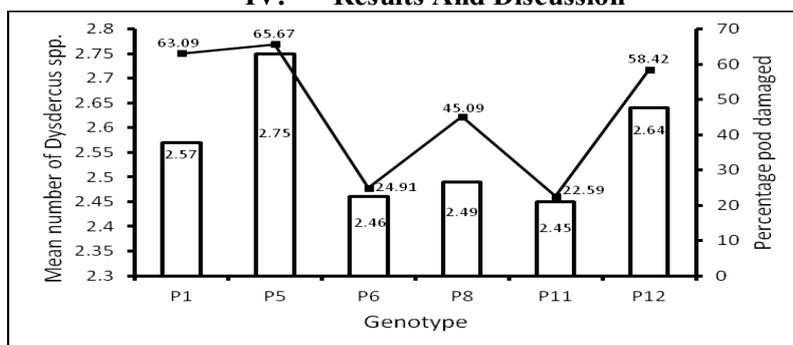


Figure 1: Population of *Dysdercus* spp. and Percentage of Pod Damaged Among The Genotypes Of West African Okra

Figure 1 shows the population of *Dysdercus supersticiosus* and percentage of pod damaged among the genotypes of West African Okra. The result shows that genotype 5 was more susceptible to pod suckers recording the highest population of *Dysdercus supersticiosus* of mean 2.75 and highest percentage of pod damage of mean 65.67% while genotype 11 recorded the lowest population of mean 2.46 and lowest percentage of pod damage of mean 22.59% indicating that genotype 11 was more resistant to the attack of pod suckers.

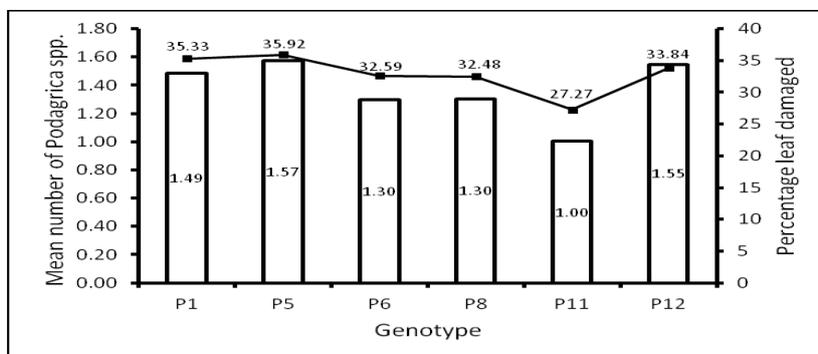


Figure 2: Population of *Podagrica* spp. And Percentage of Leaf Damaged Among The Genotypes Of West African Okra

Figure 2 shows the population of *Podagrica* spp. and percentage leaf damage among the genotypes of West African Okra. Genotype 5 recorded the highest population of *Podagrica* spp. of mean 1.57 while genotype 11 recorded the lowest population of *Podagrica* spp. of mean 1.00. The result shows that genotype 5 was more susceptible to *Podagrica* attack. Genotype 5 recorded the highest percentage of leaf damage of mean 35.92% indicating that genotype 5 is more susceptible to *Podagrica* spp. while genotype 11 recorded the lowest percentage of mean 27.27% indicating that genotype 11 is more resistant to *Podagrica* spp. attack.

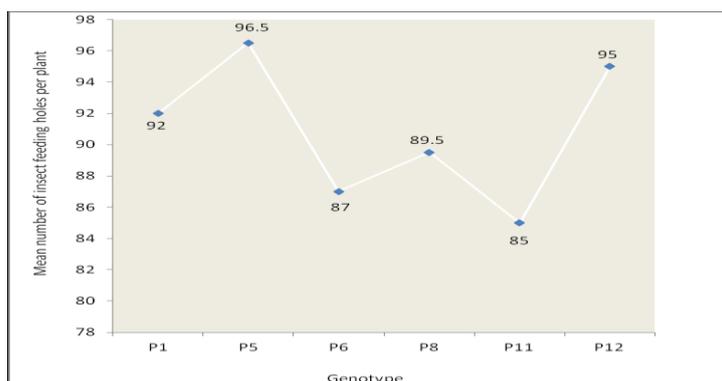


Figure 3: Number of Insect Feeding Holes per Plant Among The Genotypes Of West African Okra.

Figure 3 shows the number of insect feeding holes among the genotypes of West African Okra. Genotype 5 recorded the highest percentage of insect feeding holes per plant of mean 96.50% indicating that genotype 5 is more susceptible to *Podagrica* spp. While genotype 11 recorded the lowest percentage of mean 85.00% indicating that genotype 11 is more resistant to *Podagrica* spp. attack.

Table 2:- Seed Yield Per Plant Among the Genotypes of West African Okra.

Genotype	Seed yield per plant
P ₁	16.69
P ₅	12.90
P ₆	22.78
P ₈	21.26
P ₁₁	24.17
P ₁₂	18.20

Table 2 shows the seed yield per plant among the genotypes West African Okra. Genotype 5 recorded the lowest seed yield of mean 12.90g while genotype 11 recorded the highest seed yield of mean 24.17g. The result indicated that genotype 11 was more resistant to insect pests attack than the other genotypes and other Traits among the Genotypes of West Africa Okra.

Table3: Correlation between Seed Yield

	NFP	NDP	NLP	NDLP	NDS	NIFH	NPS	SW	
P1	NFP	1	0.555*	0.341	-0.267	0.018	-0.004	0.319	0.263
	NDP		1	0.033	-0.084	-0.200	0.218	0.378	-0.128
	NLP			1	-0.162	0.267	0.133	0.043	-0.030
	NDLP				1	-0.038	-0.301	0.525**	-0.050
	NDS					1	-0.017	-0.159	-0.0570
	NIFH						1	0.509*	0.168
	NPS							1	-0.035
	SW								1
P5	NFP	1	0.429*	0.226	0.104	0.258	0.127	0.481*	0.308
	NDP		1	0.020	0.410	0.356	0.023	0.449*	-0.215
	NLP			1	0.171	0.230	0.294	0.297	0.272
	NDLP				1	-0.097	0.064	0.442*	0.121
	NDS					1	-0.129	0.266	-0.427*
	NIFH						1	0.163	0.120
	NPS							1	0.152
	SW								1
P6	NFP	1	0.392	0.483*	-0.198	-0.037	0.577*	0.434*	0.455*
	NDP		1	0.114	-0.110	-0.157	0.373	-0.003	0.065
	NLP			1	-0.215	-0.338	0.408*	0.340	0.563*
	NDLP				1	0.261	-0.151	-0.034	0.027
	NDS					1	-0.136	0.003	-0.010
	NIFH						1	0.396	0.317
	NPS							1	0.032
	SW								1
P8	NFP	1	0.908*	0.720*	-0.172	0.339	-0.031	-0.018	0.303
	NDP		1	0.702*	-0.181	0.200	-0.052	-0.013	0.288
	NLP			1	-0.185	0.417	-0.244	-0.095	0.044
	NDLP				1	0.030	-0.127	0.083	-0.371
	NDS					1	0.495	0.063	-0.139
	NIFH						1	0.421	-0.228
	NPS							1	-0.185
	SW								1
P11	NFP	1	0.592*	0.633*	-0.200	0.045	0.441*	0.136	0.029
	NDP		1	0.087	0.070	0.088	0.279	0.156	-0.241
	NLP			1	-0.137	0.013	0.327	0.289	0.094
	NDLP				1	-0.306	0.360	0.221	-0.244
	NDS					1	0.111	-0.278	0.056
	NIFH						1	0.424*	-0.321
	NPS							1	-0.044
	SW								1
P12	NFP	1	0.774*	0.625*	-0.370	0.336	0.032	0.067	-0.217
	NDP		1	0.502*	-0.053	0.290	0.000	0.165	-0.211
	NLP			1	-0.163	0.196	0.376	0.277	0.164
	NDLP				1	-0.027	0.042	0.133	-0.097
	NDS					1	-0.380	0.173	0.177
	NIFH						1	0.117	0.030
	NPS							1	0.412
	SW								1

*. Correlation is significant at the 0.05 level (1-tailed).

** Correlation is significant at the 0.01 level (2-tailed).

NFP = Number of fruits per plant, NDP = Number of damaged pods per plant, NLP = Number of leaves per plant, NDLP = Number of damaged leaves per plant, NDS = Number of *Dysdercus supersticiosus* per plant, NIFH = Number of insect feeding holes per plant, NPS = Number of *Podagrica spp.* per plant and SW = Seed yield per plant

Table 3 shows the correlation between seed yield and the other traits among the West African okra genotypes. In genotype 6, a significant and positive correlation exists between number of fruits per plant, number of leaves per plant and seed yield. This implies that more leaves production will result in increased photosynthetic capacity of the plant which will invariably lead to more fruit production which will result in increased seed yield since more fruits will contain more seeds. A significant and positive correlation exists between number of fruits per plant and number of damaged pods in genotype 1. This implies that higher number of fruits will result in increased number of damaged pods. A positive and significant correlation exists between number of insect feeding holes and number of *Podagrica* specie which implies that the greater the number of *Podagrica* specie, the more the number of insect feeding holes that will be observed.

A negative correlation exists between number of damaged leaves, number of damaged pod and seed yield. This implies that greater number of damaged leaves and damaged pods will result in reduced seed yield. A significant and positive correlation exists between number of fruits and number of damaged pods implying that the greater the number of fruits per plant, the more the number of damaged pods that will be recorded. A negative and significant correlation exists between number of *Dysdercus spp.* and seed yield in genotype 5. This implies that higher number of *Dysdercus spp.* will result in reduced seed yield. Number of damaged pods had a positive correlation with number of *Dysdercus spp.* implying that higher population of *Dysdercus spp.* will result in increased number of damaged pods. A positive and significant correlation between number of fruit and number of leaves per plant in genotype 8 implies that the greater the photosynthetic capacity of the plant will likely result in increased number of fruits.

A positive correlation between number of damaged pods and number of *Dysdercus spp.* Indicates that the greater the population of *Dysdercus spp.*, the higher the number of damaged pods recorded. A negative correlation between number of damaged leaves, number of *Dysdercus spp.*, number of insect feeding holes, number of *Podagrica spp.* and seed yield implies that reduced number of damaged leaves, reduced population of *Dysdercus spp.* and *Podagrica spp.* and reduced number of insect feeding holes recorded will likely result in increased seed yield. A significant and positive correlation exist in number of fruits, number of damaged pods and number of leaves in genotype 12. This implies that increased number of leaves will likely result in increased number of fruits and this will lead to increased number of damaged pods. A positive correlation between number of fruits and number of *Dysdercus spp.*; and number of damaged pods and number of *Dysdercus spp.* Implies that more fruits attract higher population of *Dysdercus spp.* and this will likely result in increased number of damaged pods which will invariably result in reduced seed yield.

Table 4:- Biochemical Composition of the West African Okra Genotypes

Genotype	% Tannin	% Saponin	% Alkaloid	% Cardenoloids	% Steroid	% Terpenes
P ₁	0.069	0.430	1.150	0.230	0.210	0.043
P ₅	0.064	0.390	1.060	0.180	0.130	0.038
P ₆	0.079	0.550	2.150	0.670	0.390	0.055
P ₈	0.860	0.580	2.260	0.750	0.440	0.058
P ₁₁	0.094	0.640	2.340	0.840	0.520	0.062
P ₁₂	0.076	0.470	1.180	0.270	0.160	0.049

Table 4 shows the biochemical composition of the genotypes of West African Okra. The biochemical analysis indicates the presence of tannin, saponin, alkaloid, cardenoloids, steroids and terpenes in the genotypes. Genotype 5 recorded the least percentage of all the chemical constituents of mean 0.064%, 0.390%, 1.060%, 0.180%, 0.130% and 0.038% of the chemicals respectively. The highest percentage of the chemicals was recorded in genotype 11 of mean 0.094%, 0.640%, 2.340%, 0.840%, 0.520% and 0.062% respectively. The biochemical analysis clearly shows why genotype 11 was more resistant to both *Podagrica spp.* and *Dysdercus supersticiosus* attack than the other genotypes.

From this analysis, it was revealed that the high yielding genotype recorded a reduced population of *Podagrica spp.* and *Dysdercus spp.* The results of the biochemical analysis carried out on the genotypes revealed that the genotypes with an elevated level of the bioactive ingredient attracted less number of insect which acted as deterrents to the insects by resisting such insects from feeding and ovipositioning on them compared to the ones with low level of the bioactive ingredients. The biochemical analysis revealed the presence of tannin, saponin, alkaloid, cardenoloid, steroid, and terpenes in the genotypes. The genotype with

high percentage of these compounds recorded a lower insect population compared to the ones that contained a lower percentage of these compounds. This finding agrees with the findings of Smith (1989) that allelochemical compounds acting as deterrent are frequently alkaloids, flavonoids, terpenes, lactones and phenols. Similarly, Lale and Efevbokhan(1991) and Epino and Rejesus (1983) reported that the presence of harmful chemical compounds in the seed testa of a resistant cowpea variety prevented them from being attacked by insects.

Palaniappan and Annadurai (1999) and Farlex (2004) reported that pest repellent plants may serve as an alternative method in controlling pests in organic agriculture and thus avoid the use of synthetic pesticides. Supawan and Ranamukhaarachchi (2006) also reported the potential of integrating specific pest repellent plants in intercropping to reduce populations of specific insect pests and percentage damage and to increase the quality and marketable yield of Chinese kale, *Brassica oleracea*.

V. Conclusion

From the study it could be concluded that the resistant varieties will reduce dependency on pesticides and will save the much needed money currently being used for the purchase of chemical pesticides. Also the use of resistant varieties will eliminate the consumption of chemical pesticide which are left as residues in farm produce; also reduce the damage often done to the environment as a result of pollution through the use of pesticide. From this study, the three genotypes (NGAE-96-0067, NGEA-96-0123 and CEN 010) could be recommended to farmers due to their high fruit yield in spite of insect attack.

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