**COMPARATIVE EFFECTS OF *Fiscus exasperata* EXTRACTS ON GROWTH PARAMETERS, YIELD AND PROXIMATE CONTENTS OF AMARANTH (*Amaranthus caudatus* Lin.)**

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**ABSTRACT**

Use of plant extracts as insecticides has become popular as an alternative to synthetic insecticides but their effects as growth stimulants and nutritional enhancer should be also be evaluated. Therefore, this experiment was conducted to determine the effects of *Fiscu exasperate* leaf, back and their combination on the *Amaranthus caudatus* growth, proximate and mineral contents of the harvested leaves. Synthetic insecticide (Chlorpyrifos) and untreated plants were included in the treatments making five treatments. The experiment was arranged in Randomised Complete Block Design and each treatment was replicated three times. Data were collected on plant height, number of leaves, yield, proximate and mineral contents of the harvested leaves were determined. Data collected were subjected to statistical analysis and means were separated using Ducan multiple range test. The results showed that plant height, number of leaves and yield obtained from the amaranth plants treated with *F. exasperata* extracts were comparable with that of Chlorpyrifos. However, harvested leaves from amaranth plants treated with *F. exasperate* extracts had higher mineral and proximate contents than harvested leaves from plants sprayed with Chlorpyrifos and untreated plants. Meanwhile, *F. exasperate* leaf improved nutritional contents of the harvested leaf than *F. exasperate* back extracts and the tested *F. exasperate* leaf and back performed better than the mixture of *F. exasperate* leaf and back extracts with respect to nutritional contents but none of the plant extract formulations had negative effects on the plant growth. Therefore, *F. exasperate* extracts can be used as a major source of green vegetable plant growth and nutritional enhancer.

**Key words**: Chlorpyrifos, *Amaranthus cadatus*, *Fiscus exasperate*, Proximate contents, Mineral contents

**INTRODUCTION**

Amaranth species belong to the family Amaranthacea and includes over 70 species. Is a green vegetable which attracts farmers’ interest in connection as a result of its ethnic crop marketing due to its cultural value (Bosch *et al*., 2009). Amaranth is a very common leafy vegetable in Africa, Asian, Latino and Caribean culture. According to Robert *et al*., (2013) there was tremendous demand for the consumption of Amaranth in Africa continent which can be attributed to its important as a valuable source of food, medicine, and income for small scale farmers. Amaranth is easily cultivated, adapt well to the challenging growth environments, and has no major disease attack (Shukla *et al*., 2010). Studies have shown that Amaranthus contains high level of essential amino acids and mineral elements like calcium, iron and zinc (Andini et al*.,* 2013; Kwenin *et al.*, 2011). It is a good source of vitamins in view of the fact that it contains about thirteen timer higher iron and B-carotene (Vitamin A) which was fifty times better than cabbage (IPIGRI, 2006). It also contains several phytochemical compounds such as phenolic and flavonoids (Onyango *et al*., 2012) associated with strong antioxidant activity (Hyeon-Ju *et al*., 2015).

In Nigeria, insect pest infestation is the major problem confronting cultivation leafy vegetable of which Amaranthus species is highly susceptible to insect attack. According to Aderolu *et al*., (2013), over sixty specie of insect pests have been implicated as the major insect pests of leafy vegetable in Nigeria. Majority of these insects are leaf defoliators (Liu and Stutzel, 2002; Aderolu *et al*., 2013). Different orders have be *Sylepta derogata* (Okunlola *et al*., 2008) as well as *Hymenia recurvalis, Helicoverpa armigera* and *Spodoptera litura* (Ebert *et al*., 2011). The aforementioned order of insects caused direct loses to the quality of the leaves. For instance, Aphids infestation results into significant contamination with the honeydew and also through the growth of sooty mound, leading to market rejections (Varela and Seif, 2004). In addition, spider infestation causes leaf twisting and webbing of leaf thereby resulting to loss of market value.

In view of the destructive potential of these common insect pests of this crop, their control becomes imperative so as to obtain a reasonable yield. Poor resource farmers in Nigeria rely heavily on imported synthetic insecticides such as Lambdachyalothrin, Dirchlovous etc. due to their higher efficacy on the target insects. However, synthetic crop protection chemicals have been implicated to have caused environmental hazard and pest resistance and resurgence (Luz *et al*., 2009; Rameshwar, 2010) this couple with unavailability at critical stage (Babarinde et al., 2018) and their carcinogenic tendency (Isman and Grieneisen, 2014). These aforementioned problems have been a serious concerned to the entomologists and environmentalists in less developed countries. Different alternatives have been tested such as plant resistance, botanical insecticides and biological control for the management of field insect pests. However, botanical insecticides have been reported as a suitable alternative to synthetic insecticides due to the cost implication and availability. Botanicals are generally pest specific and are relatively harmless to non-target organisms including man (Isman, 2006). Apart from low toxicity of botanical insecticide, the processing and application of the products are not expensive as synthetic insecticide (Rameshwar, 2010).

*F. exasperate* (Vahl.) belongs to moraceae family and is popularly called sandpaper leaf tree because of its rough surface (Oladosu *et al*., 2009). Traditionally, it has been used to cure a lot of ailments, thus studies have validated this claim (Barfo and Ighinuwen, 2009). Several literatures have established F. exasperate leaves can be used as anti-ulcer, hypotensive, hypoglycemic, hypolipidemic, anti-inflammatory, anxiolytic, oxytocin inhibiting, anticonvulsant, antinociceptive, antipyretic, antimicrobial, anti -candida, insecticidal and pesticidal activities ( (Akha *et al*., 1998; Ayinde *et al*., 2007; Barfo and Ighinuwen, 2009; Woode *et al*., 2009; Adewole *et al*., 2011; Alamu, 2018). Therefore, this experiment was conducted to determine the effectiveness of *F. exasperata* leaf, back extracts and their combination as green vegetable growth and yield stimulant and their effect on the nutritional contents of the harvested Amaranthus leaves.

**MATERIALS AND METHODS**

**Study site**

The field experiment was conducted in the cropping season of 2019 and 2020 at Ladoke Akintola University of Technology (LAUTECH) Teaching and Research Farm, Ogbomoso, Oyo state. This region is on longitude 403’E and latitude 1005’N. The region can be described as humid tropical falls in Southern Guinea Savannah of Nigeria.

**Land preparation and experimental design**

After selection of the site, ploughing was done to remove roots of existing plants and weeds on the plot, debris was cleared and later harrowed in order to obtain good tilth suitable for planting and five (5) plots were demarcated and arranged in randomized complete block design with three (3) replicates. Each plots had three (3) plant rows and 2 g of *A. caudatus* was planted per planting row. The size of the plot was 3 m x 3 m with 0.5 m spacing between plots of the block and 1 m x1 m spacing between the replicates

**Preparation of plant extract**

Bark and leaves of *F. exasperate* were used for this and these plant parts were air-dried separately for two weeks to avoid photodecomposition of the chemical active compounds of the plants. The dried plant parts were crushed separately with mortar and pestle into the powdered form from which 800 g were measured out and mixed with the following inert materials: 10 g of black soap and 10 g of salt. This mixture was put into 10 liters capacity containing 3000 ml of water and stirred vigorously with stick, this was allowed to stay overnight. Filtration was done with muslin cloth and filtrates collected were stored in 5 liters plastic kegs separately as a stock solution for further use.

**Treatment application**

From the stock solutions, 1000 ml was measured out and 20% v/v was determined. Each of the botanical and nano insecticides was further diluted with 800 ml of water while 1 ml of the two tested synthetic insecticides (Chlorpyrifos) was mixed separately with 1000 ml of water. Application of treatments commenced three weeks after planting and this was done early in the morning to avoid photo decomposition of the extracts, with the hand-held sprayer to prevent drifting. Foliar application was done at 7 days interval and three weekly observations were made.

**Data collection**

 *Amaranthus* plants stands (24 plant stands) were selected randomly from each plot and tagged with a black tread from which all the data were collected. Data were collected on plant height, number of leaf and leaf yield which was calculated by weighing the harvested leaves and converted to t/ha.

**Analysis of proximate contents of harvested leaves**

**Sample Preparation**

The harvested *Amaranthus* leaves washed, stumps trimmed off (with stainless steel knife) and the knife was used to chop it in smaller pieces for easy air-drying of the samples and this was done separately according to the treatments. The samples were air-dried at room temperature. The dried material obtained was ground to a fine powder and finally packed into airtight polyethylene plastic bottles and stored in the desiccator separately until required for analysis. The dry samples were analyzed for proximate composition and minerals (Ca, Mg, Fe and K). Determinations were carried out by duplicate.

**Proximate Analysis**

Moisture, ash, crude fat, crude fat and crude fibre were determined in accordance with the official methods of the association of official analytical chemists (AOAC, 2005), while nitrogen was determined by the micro-kjeldahl method (Pearson, 1976) and the percentage of nitrogen was converted to crude protein by multiplying by 6.25.Carbohydrate was determined by difference. The result was expressed in percentage

**Mineral analysis**

The minerals in the harvested *Amaranthus* leaves were analysed from solution obtained when 2.0 g of the samples were digested with concentrated nitric acid and concentrated perchloric acid in ratios 5:3, the mixtures were placed on a water bath for three hours at 80oC. The resultant solution was cooled and filtered into 100 ml standard flask and made to mark with distilled water (Asaolu, 1995). Atomic absorption spectrophotometer (Buck scientific model200A) was used. The result was calculated in mg/100g

**Data analysis**

Data collected were analyzed using Analysis of Variance (ANOVA) and significant means were separated with Ducan multiple range text at 5% probability level.

**RESULTS**

**Effects of insecticides on yield and yield components**

The result presented in figure 1 shows the effects of insecticides applied on plant height. Amaranthus plants treated with Chlorprifos had highest plant height (71.5 cm) followed by the plant mixture of leaf and back of *F. exasperate* (68.8 cm). While the least plant height was observed (50.6) on the plants treated with *F.exasperata* leaf extracts.

However, the same significant effect was observed among the applied insecticides as well as untreated plants on number of leaves but Amaranthus plants treated with Chlorpyrifos had highest number of leaf (29.2) while the least number of leaf (25.6) was recorded on the plants treated with *F. exasperate* leaf (Fig 2).

Leaf yield obtained among the treatments was significant the same but the plants sprayed with the mixture of leaf and back of *F. exasperate* had highest Amaranth leaf yield (0.84 t/ha) meanwhile, plants treated with *F. exasperate* back extract had higher leaf yield (0.61 t/ha) than that of plants treated with *F. exasperate* leaf (0.52 t/ha). Amaranthus plants sprayed with Chlorpyrifos had 0.79 t/ha leaf yield which was higher than that of plants treated with *F. exasperate* leaf and back extracts as well as that of untreated plants (Fig 3).

**Figure 1: Effects of the insecticides on plant heights**

**Figure 2: Effects of insecticides on the number of leaves**

**Effects of insecticides on proximate contents of the harvested amaranth leaf**

As presented in table 2, significant different was detected among the treatments in respect to proximate contents. The protein contents observed among the treatments ranged from 18.38 to 24.50% with the harvested leave from plants treated with *F. exasperate* leaf had highest protein contents(24.50 %) followed by the harvested leaves from the plants treated with *F. exasperate* back. However, the least protein content (18.4%) was observed from the leaves obtained on the plants treated with Chlopyrifos. No significant different was detected from the harvested Amaranthus leaves from plants treated with the mixture of *F. exasperates* leaf and back and untreated plants.

High fibre content (16.2%) was discovered from the harvested leaves from Amaranthus plants treated with the mixture of *F. exasperate* leaf and back which was significantly higher than other treatments. Plants treated with the single application of *F. exasperate* leaf and back had higher fibre contents than the harvested leaves from the plants treated with Chlorpyrefos which had the least significant fibre contents (14.4%). Harvested leaves from plants treated with *F. exasperate* leaf extracts had the same significant effects with harvested leaves from untreated plants.

Application of *F. exasperate* leaf had the same significant fat contents (8.10%) with the harvested leaves from *F. exasperate* back extracts while the least fat contents (14.4%) was detected from the leaves from the plants treated with Chlorpyrifos. Amaranthus plants treated with the mixture of *F. exasperate* leaf and back had significant lower fat contents(8.00%) compared to the single application of *F. exasperate* leaf and back extracts.

The moisture contents of the harvested leaves ranged from 5 to 7% meanwhile, highest moisture contents(7%) was observed on the harvested leaves from plants treated with Chlorpyrifos while the least moisture content(5%) was from the harvested leaves treated with *F. exasperate* leaf and the mixture of *F. exasperate* leaf and back.

Harvested leaves from the plants treated with *F. exasperate* back had highest ash contents (14.1%) while harvested leaves from the plants treated with mixture of *F. exasperate* leaf and back had the least ash contents. Ash content (14%) discovered on the harvested leaves from plants treated with *F. exasperate* leaf was higher than the harvested leaves from the plants treated with chlorpyrefos and untreated plants.

The carbohydrate content (47.1%) in the harvested leaves from the plants treated with Chlopyrifos was significant higher than other treatments. Amaranthus plants treated with the combination of *F. exasperate* leaf and back had higher carbohydrate contents (44.3%) than the single application of *F. exasperate* leaf and back. However, none of the single application of *F. exasperate* had the same significant effect on the carbohydrate contents as it was observed on harvested leaves from untreated plants.

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| Table 4: Nutritional contents of A. hybridus as affected by insecticides |
| Proximate contents (%) |
| Treatments | Protein | Fiber | Fat | Moisture | Ash  | Carbohydrate |
| Chlorpyrifos | 18.38d | 14.40d | 6.50c | 7.00a | 13.10c | 47.12a |
| Control | 19.50c | 16.00c | 8.00b | 6.00b | 13.00d | 43.75c  |
| F. exas. Leaf | 24.50a | 16.00c | 8.10a | 5.00c | 14.00b | 37.40e |
| F. exas. Bark | 21.88b | 16.10b | 8.10a | 6.00b | 14.10a  | 39.82d |
| F. exas. L+B | 19.25c | 16.20a | 8.00b | 5.00c | 12.30e | 44.25b |

Means with the same superscript(s) are not significantly different at 5%

**Keys:**

F. exas – *Ficusexasperata*

F. exas (L+b) – *Ficusexasperata* leaf and bark

**Effects of insecticides on mineral contents of harvested amaranthus leaf**

The result presented in table 3 shows that insecticides applied had effects on the mineral contents. Highest sodium content (3.49) was observed on the harvested amaranthus leaf from plants treated with *F. exasperate* leaf extracts followed by the plants treated with *F. exasperate* back extracts which had 2.55. Least sodium content (2.08) was observed on the harvested amaranthus leaves from the plants treated with mixture of *F. exasperate* leaf and back extracts. Sodium contents(2.12) in the harvested amaranthus leaf from the plants sprayed with Chlorpyrifos was significantly low compared with sodium content on amarathus leaves from plants treated with single application of F. exasperate leaf and back extracts as well as that of untreated plants.

Amaranthus leaves harvested from untreated plants had highest calcium content (2.20) meanwhile least calcium content(1.58) was detected in the harvested leaves from the plants treated with *F. exasperate* leaf extracts. The quantity of calcium content (1.64) in the harvested amaranthus leaves from the plants treated with *F. exasperate* bark was startisitically higher than that of harvested amaranrhus leaves from the mixture of *F. exasperate* leaf and back. Amaranthus leaves treated with Chlorpyrifos had higher calcium contents (1.90) than the plants treated with *F. exasperate* extracts.

Harvested leaves from the plants treated with single application of F. exasperate leaf and back had lower iron contents than the harvested amaranthus leaves from plants sprayed with mixture of *F. exasperate* leaf and back extracts which had 15.5. However, amaranthus leaves from the plants treated with *F. exasperate* back extracts had more iron contents(14.1) than the ones harvested from the plants treated with *F. exasperate* leaf extracts which had the least iron contents compared to other applied treatments and untreated plants. None of the applied F. exasperate extracts had siginificant iron contents as it was observed in the harvested leaves from plants treated with Chlorprifos.

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| Table 2: Nutritional contents of A. hybridus as affected by insecticides |
| Mineral contents (%) |
| Treatments | Na | Ca | Fe |
| Chlorpyrifos | 2.12d | 1.90b | 16.42b |
| Control | 2.18c | 2.20a | 16.82a |
| F. exas. Leaf | 3.49a | 1.58e | 12.13e |
| F. exas. Bark | 2.55b | 1.64c | 14.08d |
| F. exas. L+B | 2.083e | 1.60d | 15.50c |

Means with the same superscript(s) are not significantly different at 5%

**DISSCUSION**

Negative implication of using insecticides especially synthetic insecticides have been reported. In view of this, there is a need to determine the effects of applied insecticides on the yield parameters as well as nutrition contents of the harvested products (Alao et al., 2020). Therefore, this experiment demonstrated the effects of Chlorpyrifos and *F. exasperate* on yield components, proximate contents and mineral contents of harvested Amaranthus leaves. However, the applied insecticides did not have negative effects on plant height, number of leaves and the yield obtained. This suggests that *F. exasperate* can be used in the cultivation of Amaranthus. This concur with the earlier research work by Iwaugwu *et al*., (2019) who reported that application of plant extracts on *Amanthus hybridus* plants did not have significant effects on plant height and total number of leaves

Data collected suggest that the insecticides had effects on the nutritional contents of the harvested Amaranthus leaf. There was a significant variation in the quantity of proximate contents of the harvested Amaranthus leaf. The observed protein contents ranged from 18.38 to 24.50% meanwhile, plants treated with Chlorpyrifos had the least protein content (18.38) while plots treated with *F. exasperate* leaf had significant highest protein contents (24.50%). According to Ali (2009), plants with the least protein content of 12% is enough as required body protein contents. Aside this, Amaranthus leaf as reported by Directorate of Plant Protection (2010) ranged from 15 to 24%. Therefore, none of the protein contents obtained was below the required plant protein. This is an indication that the applied *F. exasperate* extracts applied improved the protein contents of the harvested amaranthus leaf. The observed fibre content of the harvested Amaranthus leaf was within the range of 14.40 to 16.20% which is considerably higher than the fibre content (8.61%) reported by Akubugwo et al (2007). However, combination of *F. exasperate* leaf and back extracts significantly improved harvested Amaranthus leaf fibre content (16.2) than other treatments but least fibre contents (14.4%) were detected on the harvested leaves from plants treated with Chlorpyrifos.

The fat content of leafy vegetable has been generally reportedly low (Akubugwo *et al*., 2007). Amaranthus plants treated with *F. exasperate* leaf and back singly significantly had highest fat contents (8.1%) while Chlorpyrifos had least fat contents (6.5%) meanwhile the observed fat content is within the stated fat content which ranged from 8.3 to 27% (Sena *et al*., 1998) except the harvested leaves from amaranth plants treated with Chlorpyrifos. This is an indication that Chlorpyrifos had negative effects on the fat contents

Ash content (14.1%) observed from the harvested leaves from amaranth plants treated with *F. exasperate* back extracts was higher than other applied treatments and the least ash content (12.3%) was recorded from the amaranth plants treated with the combination of *F. exasperate* leaf and back extracts which was lower than the observed ash content (13.8%) by Akubugwo *et al*., (2007). It was observed that the single application of *F. exasperate* leaf and back had higher ash contents than harvested leaves from the untreated amaranth plants.

The observed carbohydrate contents from harvested amaranth leaves ranged from 37.4 to 47.1%. However, harvested leaves from amaranth plants treated with Chlorpyrifos had highest carbohydrate content (47.12%) while the least carbohydrate content (37.4) was observed from amaranth plants treated with *F. exasperate* leaf extracts.

This experiment clearly indicates that the applied insecticides influenced the mineral contents of the harvested amaranth leaves. The observed sodium contents ranged from 2.08 to 3.49 mg/g which was higher than 0.030 – 1.249 mg/g of sodium contents from green vegetables (Gopalan et al., 2004) meanwhile, harvested leaves from amaranth plants treated with *F. exasperate* leaf extracts had highest sodium content (3.49 mg/g). The calcium content is within the range of 1.60 to 2.20 mg/g , this is below the reported value of calcium content (1.860 – 6.338) of green vegetable by Sudeshna *et al*., (2019) but much higher than the observed calcium value (0.39 – 0.73 mg/g) by Gopalan *et al*., (2004). However, the observed calcium contents in the harvested amaranth leaves treated with *F. exasperate* leaf extracts is higher than that of Chlorpyrifos treated plants. This suggests that *F. exasperate* leaf extracts improved the calcium content of the leafy vegetables. The value of iron contents ranged from 12.13 – 16.82 mg/g and this value is considerably higher than 0.054 – 0.415 mg/g reported by Sudeshna et al., (2019). Similarly, the observed iron values from this experiment was higher than the reported iron content by Muhammed and Sharif (2011). This is an indication that *F. exasperate* is a major sources of enhancing iron content in the cultivation of leafy vegetable.

**CONCLUSION**

Based on this experiment application of *F. exasperate* extracts did not result to negative effects on the growth of the tested Amaranth plants. It was observed that the combination of leaf and back of *F. exasperate* extracts did not performed better than the single application of leaf and back of the extracts. However, harvested leaves from amaranth plants treated with tested plant extracts had higher proximate and mineral contents than the harvested amaranth leaves from plants treated with synthetic insecticides (Chlorpyrifos). Therefore, use of *F. exasperate* extracts can be described as a major sources of improving the proximate and mineral contents of leafy vegetable. Further experiment should be conducted on the use *F. exasperate* extracts on other crops as nutritional enhancer.

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