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# Effects of *Moringa oleifera* Leaf Extract on Morphological and Physiological Growth of Cassava and its Efficacy in Controlling *Zonocerus variegatus*

**Uchenna Mabel Ndubuaku**
Professor, Department of Crop Science, Faculty of Agriculture, University of Nigeria, Nsukka, Nigeria
**Theophilus Chinyere Ndubuaku**
Department of Pest Management Technology, College of Agriculture
National Root Crop Research Institute, Umudike, Abia State, Nigeria
**Emmanuel Ike**
Department of Crop Science, Faculty of Agriculture, University of Nigeria, Nsukka, Nigeria

***Abstract:***
*This work was carried out to study the effect of Moringa oleifera leaf extract (MLE) on the morphological and physiological growth characteristics of cassava (Manihot utilissima Pohl.); and its efficacy as organic insecticide for controlling Zonocerus variegatus infestation on the plant. The leaf extract was diluted in water at the ratios of 1:10, 1:20, 1:30 and 1:40. "Uppercut (R)" (30g dimethoate + 250g cypermethrin), used as water emulsifiable concentrate, was applied at the rate of 0.2 a.i./ha for comparison. Cassava hybrid, CR1247 was planted at the spacing of 1m x 1m. Moringa oleifera leaf extract was applied weekly while the dimethoate + cypermethrin was applied at three-weekly interval for two months. The experiment was laid out in a randomized complete block design (RCBD) with four replications. The Moringa oleifera leaf extract (MLE) dilution at the ratio of 1:30 MLE in water gave the highest percentage stem height difference (% SHD) at the eighth week after treatment with a value of 20.5% followed by 1:20, 1:10 MLE in water, dimethoate + cypermethrin and 1:40 MLE in water (i.e. 17.82%, 10.56%, 8.98% and 8.05% respectively). The control had the least % SHD. Dimethoate + cypermethrin had the highest percentage leaf number difference (% LND) at the eighth week after treatment with a value of 70.99% followed by 1:10, 1:30, 1:20 and 1:40 MLE in water in that order (i.e. 25.23%, 18.43%, 3.83% and 0.33% respectively). Control also had the least % LND. The 1:40 MLE in water treatment recorded the highest percentage leaf appearance (31%) at eight weeks followed by 1:30, 1:20, 1:10 and dimethoate + cypermethrin in that order (i.e. 29%, 28%, 26% and 20% respectively). Dimethoate + cypermethrin eradicated the insects and caused significant ($p < 0.05$) increase in the number of leaves and reduction in the percentage leaf abscission especially from the sixth week after treatment.*

***Key words:*** *Moringa, dimethoate + cypermethrin, insecticide, cassava hybrid*

**1. Introduction**

Cassava (*Manihot utilissima* Pohl.) belongs to the family, Euphorbiaceae and it is one of the most important root crops in the tropics especially Nigeria. Four African countries i.e. Mozambique, Nigeria, Tanzania and Zaire, are among the ten largest producers of cassava in the world (Anikwe et al., 2005). All the cultivated forms of cassava belong to the species *Manihot esculenta* Crantz and *Manihot utilissima* Pohl. These species can be distinguished based on many factors such as shape of their leaves, plant height, petiole color, leaf size etc. (Anikwe et al., 2005). Cassava can be used in various ways such as cassava pellets, cassava chips, cassava flakes and fermented cassava.

Some of the pests of cassava include termites, mites, mealybugs such as *Phenacoccus manihotis*, grasshopper such as *Zonocerus variegatus* which defoliates the leaves and reduces the photosynthetic capacity of the plant. According to Dahot (1998) and Rao et al. (2007), *Moringa oleifera* leaves possess some antibacterial and antifungal qualities. Incorporation of the green leaves into the soil had been successfully used in preventing damping off disease caused by *Pythium debaryanum* in young crop seedlings (Fuglie, 2005).

Little or no information had been given on the use of *Moringa oleifera* leaves or the extract as organic pesticide. The main objectives of this work were to determine the:

- effect of *Moringa oleifera* leaf extract application at various concentrations on some morphological and physiological characteristics of cassava.
- efficacy of *Moringa oleifera* leaf extract in controlling *Zonocerus variegatus* infestation on cassava.

**2. Materials and Methods**

The experiment was carried out in the experimental plot of Department of Crop Science, University of Nigeria, Nsukka. The treatment involved the use of different concentrations of *Moringa oleifera* leaf extract, as organic insecticide and dimethoate + cypermethrin at the rate of 0.2 a.i./ha, as inorganic insecticide to control *Zonocerus variegatus* in cassava. The dimethoate + cypermethrin used were collected from the Entomology Unit of Department of Crop Science, Faculty of Agriculture, University of Nigeria, Nsukka. The moringa leaf liquid extraction was done by pounding the fresh leaves in a clean mortar and squeezing out the liquid through a filter paper into a container. The different concentrations of the leaf extract (MLE) were made by mixing the extract in water at the following ratios: 1:10, 1:20, 1:30 and 1:40. The untreated plot acted as the control. The *Moringa oleifera* leaf extract (MLE) was applied to the cassava plants at weekly interval while the dimethoate + cypermethrin was applied at three-weekly interval using a hand sprayer to avoid drift. The spraying was done between April and June at the onset of regular rainfall when the *Zonocerus* infestation was becoming heavy. At this period, the cassava plants were between 4 to 6 months old. The cassava used was a hybrid, CR1247 and the cuttings were planted at the spacing of 1m x 1m. The experiment was laid out in a randomized complete block design (RCD) with four replications.

The morphological characteristics considered included the percentage stem height difference (% SHD). The stem height was measured with a meter rule and the percentage of the differences over the different periods of observation calculated. The number of leaves was determined by mere counting and the percentage difference (% LND) calculated at the different observation periods. The physiological growth characteristics included the rate of leaf fall (% leaf abscission) and the rate of leaf appearance (leaf flushing). The formula used for percentage leaf abscission was;

$$\% \text{ Leaf Abscission} = \frac{(T_2 - T_1)(L_1 - L_2 - nf) \times 100}{L_1 (T_2 - T_1) \times 1}$$

where $L_1$ and $L_2$ were the numbers of leaves at the periods $T_1$ and $T_2$ and nf was the number of new leaves (leaf flushes).

The formula used for percentage leaf appearance was;

$$\% \text{ Leaf Appearance} = \frac{(T_2 - T_1)(L_2 - L_1) \times 100}{L_1 (T_2 - T_1) \times 1}$$

where $L_1$ and $L_2$ were the numbers of leaves at the periods $T_1$ and $T_2$..

The insect population was determined by counting the number of insects on the plants at each period of observation and transforming the data collected into indexed values using the following formula: $Y^2 = X + 0.5$

Where Y is the insect population (indexed) and X is the number of insects on the plants.

**3. Results and Dicussion**

The percentage stem height difference (% SHD) in the cassava plants treated with 1:10, 1:20, and 1:30 of *Moringa oleifera* leaf extract (MLE) in water increased with time as shown in Table 1. There were depreciating effects of the extract mixture at the ratio; 1:40 MLE in water at six weeks after treatment (3.93%) with an increase at the eighth week (8.05%). There was a decreasing effect of Dimethoate + Cypermethrin treatment on the percentage stem height difference (% SHD) two weeks after treatment, after which the value increased steadily from the fourth to eighth week. The % SHD of the control plants decreased from sixth week after treatment. The plants treated with 1:30 MLE in water recorded the highest % SHD (20.5%) on the eighth week after treatment followed by those treated with 1:20 MLE in water (18.43%) on the sixth week. There were significant differences ($p < 0.05$) in the % SHD of the plants treated with the different ratios of MLE in water from the second to eighth week after treatment (Table 1).

| Concentration (MLE:Water) | %SHD Weeks After Transplanting (WAT) | | | |
|---|---|---|---|---|
| | 2 | 4 | 6 | 8 |
| 1:10 | 1.32 | 1.67 | 5.98 | 10.56 |
| 1:20 | 1.51 | 14.3 | 18.43 | 17.82 |
| 1:30 | 1.55 | 1.82 | 10.57 | 20.5 |
| 1:40 | 3.31 | 8.31 | 3.93 | 8.05 |
| Dimethoate + Cypermethrin | 2.54 | 5.99 | 7.26 | 8.98 |
| Control | 2.82 | 15.29 | 7.95 | 3.82 |
| Mean | 2.175 | 7.9 | 9.02 | 11.62 |
| F-LSD $_{0.05}$ | NS | 2.5 | 2.26 | 2.79 |

*Table 1: Effect of different concentrations of Moringa oleifera leaf extract (MLE) and dimethoate + cypermethrin on percentage stem height difference (% SHD) of cassava between 2 and 8 weeks after treatment (WAT)*

- NS means not significant
- MLE means *Moringa oleifera* leaf extract

With the exception of the plants treated with dimethoate + cypermethrin, the percentage difference in the number of leaves (% LND) in the MLE-treated plants, including the control, decreased with time. The 1:10 MLE in water treatment caused a reduction in the % LND at eight weeks while in the other treatments, with the exception of dimethoate + cypermethrin treated plants, the reduction started from six weeks (Table 2). There were significant differences ($p < 0.05$) across the treatments from two to eight weeks after treatment.

| Concentration (MLE:Water) | %LND Weeks After Transplanting (WAT) | | | |
|---|---|---|---|---|
| | 2 | 4 | 6 | 8 |
| 1:10 | 7.6 | 43.70 | 46.86 | 25.23 |
| 1:20 | 6.51 | 49.04 | 16.47 | 3.83 |
| 1:30 | 3.73 | 43.14 | 33.73 | 18.43 |
| 1:40 | 7.52 | 29.43 | 23.07 | 0.33 |
| Dimethoate + Cypermethrin | 12.08 | 50.18 | 61.33 | 70.99 |
| Control | 6.43 | 69.5 | 31.27 | 7.72 |
| Mean | 7.31 | 47.49 | 35.46 | 21.08 |
| F-LSD$_{0.05}$ | 1.9 | 4.25 | 4.36 | 4.22 |

*Table 2: Effect of different concentrations of Moringa oleifera leaf extract (MLE) and dimethoate + cypermethrin on percentage leaf number difference (% LND) of cassava plants between 2 and 8 weeks after treatment (WAT)*

- NS means not significant
- MLE means *Moringa oleifera* leaf extract

The percentage leaf abscission (% LA) in all the treatments, except dimethoate + cypermethrin, increased from sixth week after treatment with the initial decrease at the fourth week after treatment. The % LA in the dimethoate + cypermethrin treated plants decreased consistently from the second to the eighth week after treatment. The highest % LA (30%) was obtained in the control plants at eight weeks after treatment (Table 3). There were significant differences ($p < 0.05$) in the % LA of the plants across the treatments from second to eighth week after treatment.

| | Percentage leaf abscission (%) | | | | |
|---|---|---|---|---|---|
| **Concentration (MLE:Water)** | **Before treatment** | **2 WAT** | **4 WAT** | **6 WAT** | **8 WAT** |
| 1:10 | 15 | 13 | 10 | 18 | 25 |
| 1:20 | 18 | 16 | 12 | 22 | 24 |
| 1:30 | 20 | 16 | 13 | 19 | 25 |
| 1:40 | 21 | 18 | 15 | 20 | 26 |
| Dimethoate + Cypermethrin | 21 | 8 | 2 | 0 | 0 |
| Control | 22 | 23 | 21 | 26 | 30 |
| Mean | 19.5 | 15.67 | 12.17 | 17.5 | 21.67 |
| F-$LSD_{0.05}$ | 2.02 | 2.67 | 3.04 | 4.04 | 4.79 |

*Table 3: Effect of different concentrations of Moringa oleifera leaf extract (MLE) and dimethoate + cypermethrin on percentage leaf abscission (%LA) in cassava between 2 and 8 weeks after treatment (WAT)*

- NS means not significant
- MLE means *Moringa oleifera* leaf extract
- WAT means weeks after treatment

The treatment effect on percentage leaf appearance (leaf flushing) is shown in Table 4. It increased progressively and consistently in all the treatments, including the control, from the second to the eighth week after treatment. However, 1:40 MLE in water gave the highest percentage leaf appearance at the eighth week after treatment followed by 1:30, 1:20, 1:10, dimethoate + cypermethrin and control in that order (i.e. 31%, 29%, 28%, 26%, 20% and 17% respectively). There were no significant differences ($p > 0.05$) across the various treatments in the first two weeks after treatment but there were significant differences ($p < 0.05$) between fourth and eighth week after treatment (Table 4).

| **Concentration (MLE:Water)** | **Percentage leaf appearance (flushing)** | | | | |
|---|---|---|---|---|---|
| | **Before treatment** | **2 WAT** | **4 WAT** | **6 WAT** | **8 WAT** |
| 1:10 | 5 | 8 | 14 | 20 | 26 |
| 1:20 | 6 | 10 | 17 | 23 | 28 |
| 1:30 | 5 | 12 | 19 | 24 | 29 |
| 1:40 | 5 | 11 | 21 | 26 | 31 |
| Dimethoate + Cypermethrin | 5 | 7 | 12 | 16 | 20 |
| Control | 5 | 7 | 10 | 13 | 17 |
| Mean | 5.17 | 9.17 | 14.0 | 20.33 | 25.17 |
| F-$LSD_{0.05}$ | NS | NS | 2.0 | 2.44 | 2.67 |

*Table 4: Percentage leaf appearance (flushing) in cassava weeks after treatment (WAT) with different concentrations of Moringa oleifera leaf extract (MLE) and dimethoate + cypermethrin*

- NS means not significant
- MLE means *Moringa oleifera* leaf extract
- WAT means weeks after treatment

Data comparing the effects of *Moringa oleifera* leaf extract (MLE) and dimethoate + cypermethrin on *Zonocerus variegatus* population are shown in Table 5. The population of the insect in the plot treated with dimethoate + cypermethrin decreased progressively from first to seventh week after treatment. There was an increase in the insect population in all the *Moringa oleifera* leaf extract treated plants, as well as the control, from the fifth week after treatment. The control plants had the highest insect population (2.63) followed by the plants treated with 1:10, 1:30, 1:40 and 1:20 MLE in water in that order (i.e. 2.44, 2.38, 2.37 and 2.32 respectively). There were significant differences ($p < 0.05$) in the insect population across the treatments from the sixth to the seventh week after treatment.

| Concentration (MLE:Water) | Weeks After Transplanting | | | | | | | | Treat-ment mean |
|---|---|---|---|---|---|---|---|---|---|
| | Before treatment | 1 WAT | 2 WAT | 3 WAT | 4 WAT | 5 WAT | 6 WAT | 7 WAT | |
| 1:10 | 2.12 | 2.35 | 2.12 | 1.87 | 2.35 | 2.74 | 2.92 | 3.09 | 2.45 |
| 1:20 | 1.87 | 2.12 | 2.35 | 1.87 | 2.12 | 2.55 | 2.92 | 2.74 | 2.32 |
| 1:30 | 2.35 | 2.35 | 2.12 | 2.12 | 2.12 | 2.35 | 2.74 | 2.92 | 2.38 |
| 1:40 | 2.12 | 1.87 | 2.12 | 1.87 | 2.12 | 2.35 | 3.24 | 3.24 | 2.37 |
| Dimethoate + Cypermethrin | 2.35 | 1.87 | 1.58 | 1.22 | 1.22 | 1.22 | 0.71 | 0.71 | 1.36 |
| Control | 2.35 | 2.55 | 2.12 | 2.35 | 2.12 | 2.74 | 3.39 | 3.39 | 2.63 |
| Mean | 2.19 | 2.07 | 2.07 | 1.88 | 2.01 | 2.33 | 2.65 | 2.68 | |
| F-$LSD_{0.05}$ | NS | NS | NS | NS | NS | NS | 1.39 | 1.40 | |

*Table 5: Effect of Moringa oleifera leaf extract (MLE) and dimethoate + cypermethrin on mean population of Zonocerus variegatus in a cassava plot between 1 and 7 weeks after treatment (WAT)*

- NS means not significant
- MLE means *Moringa oleifera* leaf extract
- WAT means weeks after treatment

The high values of percentage stem height difference (% SHD) obtained in 1:10, 1:20 and 1:30 MLE in water especially at the eighth week after treatment could be attributed to the high nutritional values of the extract at these concentrations. Fuglie (1999; 2000) observed that 1:32 MLE in water increased the growth and yield of maize and other crops by 30%. The dimethoate + cypermethrin treatment gave the highest percentage leaf number difference (70.99) at the eighth week after treatment and the value increased consistently from four to eight weeks after treatment. This could be ascribed to the total eradication of the insect especially at the sixth and seventh week after treatment, thus, reducing the level of defoliation (leaf abscission) and increasing the total number of leaves especially with the new flushes emerging over the period. The high nutritional qualities of *Moringa oleifera* leaf extract further increased the general growth of the plants and enhanced the rate of leaf appearance on the MLE treated plants as earlier reported (Fuglie, 1999 ; 2000). Ndubuaku et al. (2006) and Winter (1985) observed that increase in the number of leaves as a result of leaf flushing enhanced the photosynthetic capacity of cocoa plants, increased the photosynthate accumulation and total yield.

At all the concentrations of *Moringa oleifera* leaf extract and the control, the insect population increased from the fifth week of treatment application which coincided with the period of heavy rain (around May/June). Fuglie (1999; 2000; 2005) and Johnson (2005) reported that *Moringa oleifera* leaves and young shoots could be used for animal feed because of their high nutrient contents. Thus, the leaf extract, instead of acting as organic insecticide, could have been a source of nutrition for the insect to increase its strength and destructive abilities. This reflected in the high rate of defoliation/ leaf abscission recorded from sixth week of treatment when the level of insect infestation in the plot increased. Dimethoate + cypermethrin controlled the insect population in the plot better than *Moringa oleifera* leaf extract. This was evident in the high reduction in the population of the insect in the dimethoate + cypermethrin -treated plants all through the period of observation. This ultimately enhanced the morphological growth (stem height and number of leaves) of the plants treated with dimethoate + cypermethrin because they were not prone to much destruction by the insect attack. However, this does not negate the importance of organic pesticide use in a good integrated pest management (IPM) program. Higher concentrations and the undiluted form of the *Moringa oleifera* leaf extract can also be tried in further experiments to ascertain the level that can be toxic to the insect. Efforts to isolate the active ingredients in the leaf extract are important to know if *Moringa oleifera* leaf extract had any insecticidal quality.

**4. References**


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