**ORIGINAL RESEARCH ARTICLE**

**Effectiveness of Intercropping Maize and Cucumber in Managing *Epilachna elaterii* Rossi and Fruit Fly Infestation**

**ABSTRACT**

This experiment was carried out to evaluate the effect of different planting dates (time) in intercropping cucumber with maize on insect-pests and yield of cucumber in 2023 and 2024 planting seasons in Calabar, Cross River State, Nigeria. The field trials were carried using various intercropping planting dates. The three intercropping planting dates (time) included; Planting of cucumber with maize the same day, Planting of cucumber two weeks after maize and Planting of cucumber two weeks before maize. Four varieties of cucumber namely; Mona Lisa, Murano 2, Nandini 732 and cucumber marketer were used while only one maize variety, ART -98-SWI was used in the experiment. The experiment was laid out in a Randomized Complete Block Design (RCBD) with four replications per treatment. The major insect pests assessed in the field were; *Epilachna elaterii* and fruit flies. The data obtained from the field trials were subjected to Analysis of Variance (ANOVA) using GenStat statistical software. Cucumber planted on the same day as of maize and cucumber planted two weeks after maize had lower population density of *E. elaterii* compared to cucumber planted two weeks before maize. However, planting date had no significant effect on fruit fly infestation. Yield was highest in cucumber planted on the same day as maize. In the experiment, intercropped cucumber had lower insect pests’- population density compared to sole cucumber cropping. Nandini 732 had relatively reduced pest pressure and higher yield in the experiment. These results suggest that intercropping of cucumber with maize is effective in managing insect pests of cucumber. Therefore, simultaneous planting of cucumber and maize is recommended for improved pest control and enhanced cucumber yield.

**Keywords: Cucumber-maize intercropping, Planting dates, *Epilachna elaterii*, fruit flies, RCBD.**

**Introduction**

Cucumber, *Cucumis sativus* L. is an annual, warmth loving season crop primarily cultivated for its fruits. It is the most economically important cucurbit and ranks as the fourth most important vegetable globally (Capinera, 2020; Odewole *et al.,* 2020). *Cucumis sativus* L. is a member of a trailing crop known as cucurbitaceae (Khan *et al.,* 2015; Esmaielpour *et al*., 2020; Khorram and Mohamady, 2020; Srinivas *et al.,* 2022). The crop like most cucurbits, are indeterminate with a vine length of 1 to 3 meters in length (Wehner *et al.,* 2020). Cucumber fruits serve as rich source of basic nutrients such as protein, carbohydrate, fibre, vitamin (A1, B1, B2, B6, C, E, K), Sodium, Potassium, Calcium, Copper, Zinc, Silica, fibre and Iron (Changade and Ulemale, 2015; liu *et al.,* 2017; Wahba *et al*., 2017; Odewale *et al*., 2018; Ingle and Shyamroa, 2020; Susan *et al.,* 2019; Otie *et al.,* 2024). Since, the fruit contains about 95% of water, it aids in digestion of food, eliminate toxins, keep the body hydrated (Bidein *et al.,* 2016; Uzuazokaro *et al*., 2018) and as such control digestive disorders such as heat burn, gastritis and ulcers (Elemi *et al.,* 2024). The young leaves and stems of Cucumber are cooked in Southern Asia and eaten as meal (Wehner *et al*., 2020) and their fruit are used in curries, chutneys in India and are widely consumed as salad across the world (Wehner *et al*., 2020; Kumar *et al*., 2021). The seed or fruit extracts of cucumber serve as anthelmintic medicine (Rajasree *et al.,* 2016).

One of the major constraints to profitable Cucumber cultivation is the significant crop damage caused by increasing insect pest infestations (Shinde *et al*., 2018). In severe cases, there is a 100 percent yield loss due to viral diseases vectored by insects (Umeh and Ojiako, 2018; Pogen, 2021; Ukatu *et al*., 2024). Many of these insect pests result in both qualitative and quantitative loss in cucumber. Some of the major insect pests of cucumber include the following; *Aulacophora* spp (*Aulacophora foveicollis* Lucas, *Aulacophora hilaris* Boisduval, *Aulacophora nigripennis* Motschulsky), Cucumber beetles (*Acalymma vittatum* Fabricius, Diabrotica *undecimpunctata* Howardi Barber), Epilachna beetles (*Epilachna chrysomelina* Fabricius, *E. elaterii* Rossi), Fruit flies (*Bactrocera cucurbitae* Coquillet, *B. invadens* Drew, Tsuruta & White, *Dacus ciliatus* LW), Melon Aphids (*Aphis gossypii* Glover) etc. Synthetic insecticides have been widely used by farmers to combat this menace despite its huge adverse effect to man’s health and the environment. To address all these challenges posed by the use of synthetic chemicals, there is an urgent need of use eco-friendly pest management strategies. One of such approach is the intercropping of cucumber with maize to manage insect pests of cucumber. The preservation of biodiversity and promotion of agricultural practices that respect the limits of the environment are essential to ensure the continuity of food production in the long term (FAO, 2023). Unlike monoculture practices which has accentuate insect pests’ problems in ecosystem, the adoption of intercropping helps to brings some balance in the ecosystem (Gagic *et al*., 2021). Therefore, the present study investigates the effectiveness of different planting dates (timing) that could be adopted for intercropping of cucumber with maize for the management of fruit flies and *E. elaterii* Rossi on cucumber.

**MATERIALS AND METHODS**

The experiments were carried out in 2023 and 2024 late and early planting seasons respectively in Calabar, Cross River State, Nigeria (04◦58N, 08◦21E, 37 m above sea level). Calabar is characterized by a bimodal annual rainfall distribution pattern ranging from 3000-3500mm with a mean annual temperature which ranges from 27℃ to 35℃ and relative humidity of between 75-88%.

All the experimental plots used in this research were manually cleared, stumped, raked and tilled with the aid of cutlass, rake and hoe. The four varieties used in the experiment includes the following:

Mona –Lisa (East-West Seed International) cucumber marketer (Agricultural Ltd Nigeria), Murano 2 (Technisem- France) and Nandini 732. The maize variety used for the experiment is ART – 98-SWI sourced from the Institute of Agricultural Research and Training, Moor Plantation, Ibadan. The experimental setups involved four cucumber varieties and one maize variety. The experiments were laid out in a Randomized Complete Block Design and replicated four times.

The planting time adopted in this experiment is thus; planting of maize two weeks after cucumber, planting of maize two weeks before cucumber and planting of maize and cucumber at the same time. Each of the cucumber variety was intercropped with maize based on the three timing above and sole-cropping of cucumber served as control in the experiment. The experiment had a total of 13 treatments replicated four times. The plant population density was 17,778 plants/ha (i.e. 8,889 plants each for cucumber and maize). The spacing used in the experiment was 75cm x 75cm, each treatment plot measured 4.5m x4.5m (20.25m2) while the total land area used for the experiment was 72.5m x 23m (1,667.5m2).

**Data collection**

Insect Population Densities**:**

Sampling was conducted at four weeks after planting (24days) and subsequently at two-week intervals till fruit maturity. Observations were made between 7:00am- 9:00am when insects activity was relatively low.

The population densities of *Epilachna* beetles were determined by visually counting the insects on six randomly selected plants per plot, chosen from the middle rows.

Agronomic Data: Data on the number of leaves and vine length were recorded at 6 weeks after planting (6 WAP) from six randomly selected plants in the middle of each plot.

Fruit Yield: Undamagedfruits harvested from each of the six plants at the middle of each plot were weighed and recorded as yield per plot and the data was later expressed in tonnes per hectare.

Harvesting commenced at 50 days when the cucumber fruits have changed from their dull to glossy green colour. Harvesting was done with a pair of scissors in order to avoid fruit tear during harvesting. Fruits collected from the plant were grouped into undamaged and damage fruits. Damage by fruit flies was characterized by tunnels inside the fruit and exit holes on the fruit.

**Data analysis**

All data on insect population were transformed using square root transformation (√x+0.5) before being subjected to Analysis of Variance (ANOVA). Significant mean values were separated using Tukey’s Honest Significant Difference (HSD) test at 5% probability level.

**RESULTS**

The effect of planting date in cucumber –maize intercropping on the population of fruit flies and *Epilachna elaterii* Rossi is shown in Table 1. There was significant (P<0.05) difference among the treatments used in the experiment at both planting seasons. No significant (P>0.05) differences exist within intercrop of the same variety of cucumber with maize at different planting dates in respect to the population density of fruit flies. All varieties of cucumber intercropped with maize on the same day (time) had significant (P<0.05) reduction in the population density of fruit flies when compared with sole-cucumber intercropping system except the intercrop of cucumber marketer with maize in both planting seasons. There was no significant (P>0.05) difference in cucumber varietal response to fruit flies’ population density within any given planting date.

The cucumber intercropped with maize at the same time (day) and the ones planted after two weeks of maize introduction had significantly (P<0.05) lower infestation of *E. elaterii* Rossi than the varieties of cucumber introduced two weeks before the maize in the field at both years except in 2023 when the intercrop of Mona Lisa and Nandini 732 varieties with maize two weeks after the introduction of cucumber was statistically (P>0.05) at per with that of the introduction of maize and cucumber at the same time (date). At both years, the intercropping of cucumber with maize had significant (P<0.05) reduction in the population density of *E. elaterii* Rossi than that of the sole-cucumber crop except the intercrop of Nandini 2 and cucumber marketer variety two weeks before maize in 2024 planting season.

**Table 1: Effect of Planting Date in Cucumber-Maize Intercropping on the Population of Fruitfly and *Epilachna elaterii* Rossi**

**TREATMENT FRUITFLIES 2023 FRUITFLIES 2024 *E. elaterii* 2023 *E. elaterii* 2024**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Va+M2WAC | 1.12±0.24ab | 0.97±0.10b | 3.25±0.10d | 2.65±0.18bc |
| Va+M2WBC | 1.07±0.22b | 0.89±0.12b | 2.42±0.05d | 2.31±0.06cd |
| Va+MSDC | 1.09±0.12b | 1.16±0.16ab | 2.23±0.06d | 2.18±0.05d |
| Vm+M2WAC | 1.03±0.08b | 1.26±0.12ab | 3.50±0.09b | 3.03±0.02b |
| Vm+N2WBC | 1.14±0.23ab | 1.35±0.17ab | 2.43±0.10bc | 2.28±0.05cd |
| Vm+MSDC | 0.83±0.05b | 1.04±0.16b | 2.29±0.10d | 2.18±0.05d |
| Vn+M2WAC | 1.27±0.06ab | 1.10±0.04ab | 3.05±0.02d | 3.60±0.13a |
| Vn+M2WBC | 1.31±0.20ab | 1.43±0.16b | 2.42±0.05c | 2.42±0.05cd |
| Vn+MSDC | 1.00±0.00b | 0.84±0.06b | 3.23±0.06d | 2.26±0.02cd |
| Vo+M2WAC | 1.30±013ab | 1.31±0.15ab | 3.14±0.04c | 3.60±0.14a |
| Vo+M2WBC | 1.39±0.17ab | 1.40±0.23ab | 2.37±0.04d | 2.28±0.05cd |
| Vo+MSDC | 1.39±0.19ab | 1.38±0.17ab | 2.23±0.06d | 2.18±0.05d |
| Sole Cucumber | 1.87±0.02a | 1.80±0.14a | 3.82±0.05a | 3.81±0.05a |
| SED | 0.22 | 0.20 | 0.10 | 0.12 |
| COV(%) | 25.5 | 23.6 | 5.0 | 6.1 |

Means along a column with the same alphabet(s) as superscript are not significantly different at P>0.05, according to the Tukey Honest Significant Test.

**Keys**

Va+M2WAC: Planting of Maize 2weeks after MONA LISA variety of cucumber

Va+M2WBC: Planting of Maize 2weeks before MONA LISA variety of cucumber

Va+MSDC: Planting of maize and MONA LISA variety of cucumber at the same time (date)

Vm+M2WAC: Planting of Maize 2weeks after MURANO 2 variety of cucumber

Vm+M2WBC: Planting of Maize 2weeks before MURANO 2 variety of cucumber

Vm+MSDC: Planting of maize and MURANO 2 variety of cucumber at the same time (date)

Vn+M2WAC: Planting of Maize 2weeks after NANDINI 732 variety of cucumber

Vn+M2WBC: Planting of Maize 2weeks before NANDINI 732 variety of cucumber

Vn+MSDC: Planting of maize and NANDINI 732 variety of cucumber at the same time (date)

Vo+M2WAC: Planting of Maize 2weeks after CUCUMBER MARKETER variety

Vo+M2WBC: Planting of Maize 2weeks before CUCUMBER MARKETER variety

Vo+MSDC: Planting of maize and CUCUMBER MARKETER variety at the same time (date)

Sole cucumber: Cucumber monoculture

SED: Standard Error of Difference of Means

COV: Co-efficient of Variability

The effect of planting date in cucumber –maize intercropping on vine length and number of leaves per plants is shown in Table 2.

The result showed that significant (P<0.05) difference existed in vine length and number of leaves per plant at different planting dates in both planting seasons (2023 and 2024).

The result indicated that at both years, the planting of maize two weeks after cucumber was not significantly (P>0.05) different from the planting of cucumber and maize on the same day in terms of number of leaves per plant and vine length of cucumber in the intercropping system. Both cucumbers planted two weeks before maize and the ones in which cucumber and maize were planted on the same day were statistically (P>0.05) at par with the sole-cucumber cropping. However, cucumber planted two weeks before maize and the ones in which maize and cucumber were planted the same day had significantly (P<0.05) longer vine length and higher number of leaves than that of cucumber planted two weeks after maize.

Similarly, at both years, sole-cucumber cropping system produced number of leaves that was statistically (P>0.05) at par with the ones produced by cucumber intercrop with maize at the same day (time) and cucumber planted two weeks before the introduction of maize in the intercrop system.

There was significant (P<0.05) varietal difference in vine of cucumber at both years, with Nandini 732 having significantly (P<0.05) higher vine length than Mona Lisa and Cucumber marketer variety when cucumber crops were planted two weeks before maize while cucumber marketer had significantly (P<0.05) shorter vine length than other varieties when cucumber and maize were both planted at the same date. Similarly, Nandini 732 variety had significantly (P<0.05) higher number of leaves than other varieties when cucumber crops were planted two weeks before maize while cucumber marketer and Mona Lisa were at par but significantly (P<0.05) had higher number of leaves when compared with Murano 2 and Nandini variety in 2023. In 2024, cucumber marketer variety had significantly (P<0.05) lower number of leaves when cucumber was planted two weeks before maize and when both crops were planted at the same date, respectively.

**Table 2: Effect of Planting Date in Cucumber-Maize Intercropping on Vine length and Number of Leaves of Cucumber**

**Treatment Vine length 2023 Vine length 2024 Number of Leaves 2023 Number of Leaves 2024**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Va+M2WAC | 172.8±3.63b | 174.30±6.79b | 18.79±0.64c | 28.00±0.68a |
| Va+M2WBC | 77.6±3.95d | 87.70±2.08d | 13.50±0.38d | 18.58±0.66bc |
| Va+MSDC | 188.7±2.60ab | 194.3±4.48ab | 17.03±068cd | 23.04±0.95a |
| Vm+M2WAC | 176.1±6.57ab | 192.7±3.27ab | 27.02±0.47b | 28.29±0.95a |
| Vm+N2WBC | 59.0±12.47d | 96.2±1.83d | 15.67±0.81cd | 19.00±0.42bc |
| Vm+MSDC | 181.8±6.57ab | 201.6±5.60a | 28.34±1.15b | 27.25±0.99a |
| Vn+M2WAC | 202.4±7.70a | 199.8±2.18a | 33.46±0.95a | 27.50±0.73a |
| Vn+M2WBC | 78.9±5.67d | 107.7±0.62d | 15.56±1.63cd | 20.08±0.56bc |
| Vn+MSDC | 195.0±3.51ab | 203.3±3.65a | 33.59±1.00a | 25.42±0.22a |
| Vo+M2WAC | 126.4±3.41c | 142.0±3.17c | 18.50±0.42c | 20.21±0.72bc |
| Vo+M2WBC | 82.0±1.50d | 92.3±4.33d | 13.00±1.15d | 16.63±0.84c |
| Vo+MSDC | 131.3±0.93c | 148.7±405c | 16.26±1.42cd | 21.38±0.85b |
| Sole Cucumber | 202.0±6.81a | 211.3±9.99a | 33.34±0.64a | 28.63±1.24a |
| SED | 8.07 | 6.22 | 1.21 | 1.05 |
| COV(%) | 7.9 | 7.9 | 7.9 | 6.2 |

Means along a column with the same alphabet(s) as superscript are not significantly different at P>0.05, according to the Tukey Honest Significant Test.

**Keys**

Va+M2WAC: Planting of Maize 2weeks after MONA LISA variety of cucumber

Va+M2WBC: Planting of Maize 2weeks before MONA LISA variety of cucumber

Va+MSDC: Planting of maize and MONA LISA variety of cucumber at the same time (date)

Vm+M2WAC: Planting of Maize 2weeks after MURANO 2 variety of cucumber

Vm+M2WBC: Planting of Maize 2weeks before MURANO 2 variety of cucumber

Vm+MSDC: Planting of maize and MURANO 2 variety of cucumber at the same time (date)

Vn+M2WAC: Planting of Maize 2weeks after NANDINI 732 variety of cucumber

Vn+M2WBC: Planting of Maize 2weeks before NANDINI 732 variety of cucumber

Vn+MSDC: Planting of maize and NANDINI 732 variety of cucumber at the same time (date)

Vo+M2WAC: Planting of Maize 2weeks after CUCUMBER MARKETER variety

Vo+M2WBC: Planting of Maize 2weeks before CUCUMBER MARKETER variety

Vo+MSDC: Planting of maize and CUCUMBER MARKETER variety at the same time (date)

Sole cucumber: Cucumber monoculture

SED: Standard Error of Difference of Means

COV: Co-efficient of Variability

The effect of planting date in cucumber –maize intercropping in the yield of cucumber fruit (kg/plot) is shown in Table 3. The result showed that planting date in cucumber –maize intercropping system had significant (P<0.05) effect on the yield of cucumber.

At both years, the result indicated that cucumber planted the same date with maize had significantly (P<0.05) higher fruit yield (Kg/plot) than cucumber planted two weeks before maize and cucumber planted two weeks after maize respectively except the intercrop of maize with cucumber marketer in 2023, where cucumber planted at the same date with maize only had significantly (P<0.05) higher yield (Kg/plot) than cucumber planted two weeks after maize but at par with cucumber planted two weeks before maize. Cucumber planted with maize at the same time were statistically (P>0.05) at par with that of sole –cucumber system in terms of fruit yield (Kg/plot) except cucumber marketer intercropped with maize in 2024 that was significantly (P<0.05) lower than its sole-cucumber cropping system. In both 2023 and 2024, the fruit yield (Kg/ha) in which cucumber was planted at the same date with maize and the ones that cucumber was planted two weeks before maize had Mona Lisa, Murano and Nandini 732 significantly (P<0.05) higher fruit yield (Kg/plot) than cucumber marketer.

**Table 3: Effect of Planting Date in Cucumber- Maize Intercropping on the Yield of Cucumber Fruit**

|  |  |  |
| --- | --- | --- |
| **Treatment** | **Fruit yield of 6 plants (K/plot) 2023** | **Fruit yield of 6 plants (Kg/plot)) 2024** |
| Va+M2WAC | 3.44+0.34cd | 3.24+0.17cde |
| Va+M2WBC | 2.58+0.25def | 2.58+0.22def |
| Va+MSDC | 5.10+0.21ab | 5.16+0.20ab |
| Vm+M2WAC | 3.96+0.24bc | 3.30+0.17cde |
| Vm+N2WBC | 2.70+0.05def | 2.50+0.19ef |
| Vm+MSDC | 5.18+0.16ab | 5.52+0.24ab |
| Vn+M2WAC | 3.43+0.21cd | 3.67+0.16c |
| Vn+M2WBC | 2.45+0.15def | 2.85+0.04cdef |
| Vn+MSDC | 5.42+0.15a | 5.99+0.22a |
| Vo+M2WAC | 1.95+0.12ef | 2.01+0.24fg |
| Vo+M2WBC | 1.65+0.43f | 1.24+0.28g |
| Vo+MSDC | 3.11+0.26cde | 3.53+0.17cd |
| Sole Cucumber | 4.19+0.32abc | 4.74+0.19b |
| SED | 0.35 | 0.28 |
| COV(%) | 14.4 | 11.1 |
|  |  |  |

Means along a column with the same alphabet(s) as superscript are not significantly different at P>0.05, according to the Tukey Honest Significant Test.

**Keys**

Va+M2WAC: Planting of Maize 2weeks after MONA LISA variety of cucumber

Va+M2WBC: Planting of Maize 2weeks before MONA LISA variety of cucumber

Va+MSDC: Planting of maize and MONA LISA variety of cucumber at the same time (date)

Vm+M2WAC: Planting of Maize 2weeks after MURANO 2 variety of cucumber

Vm+M2WBC: Planting of Maize 2weeks before MURANO 2 variety of cucumber

Vm+MSDC: Planting of maize and MURANO 2 variety of cucumber at the same time (date)

Vn+M2WAC: Planting of Maize 2weeks after NANDINI 732 variety of cucumber

Vn+M2WBC: Planting of Maize 2weeks before NANDINI 732 variety of cucumber

Vn+MSDC: Planting of maize and NANDINI 732 variety of cucumber at the same time (date)

Vo+M2WAC: Planting of Maize 2weeks after CUCUMBER MARKETER variety

Vo+M2WBC: Planting of Maize 2weeks before CUCUMBER MARKETER variety

Vo+MSDC: Planting of maize and CUCUMBER MARKETER variety at the same time (date)

Sole cucumber: Cucumber monoculture

SED: Standard Error of Difference of Means

COV: Co-efficient of Variability

**DISCUSSION**

In this study, densities of *Epilachna elaterii* Rossi and fruit flies were significantly reduced in cucumber-maize intercropping system, especially for cucumber and maize planted at the same date. This observation is in conformity with that of Pitan and Filani (2014) that reported better protection of cucumber from insect - pests’ infestation and fruit damage associated with cucumber planted the same date (day) with maize.

This reduction in pest population in intercropped plants may be attributed mostly to the micro-environment effects of the associated crops such as visual or olfactory interference, low resource concentration, landing disruption and enhanced natural enemy population (Pitan and Filani, 2014). This observable reduction in the infestation level may be explained by the position of Pitan and Filani (2014) that attributed it to the greenery cover provided by well-established maize at this planting times during the vegetative stage thereby providing cover for the plants to be hidden from insect that attacks this plant unlike at other time that provided less cover to protect the plant.

The yield of six cucumber plants harvested from each plot in cucumber planted at the same date (time) with that of maize had higher fruit yield than other cucumber intercropped with maize at different times (dates). This situation may be due to well-establishment of natural enemies of the crop before flowering and fruiting which gave optimum protection of the crop by their predator to the cucumber. This observation is in conformity with the result of Diniz *et al.* (2017) and Zarei *et al*. (2018).

**CONCLUSION**

Intercropping of cucumber on the same day with maize had better protection of cucumber from insect pests of cucumber and resulted in a higher yield of cucumber fruits compared to the planting of cucumber and maize at different dates (time). Therefore, it could be recommended that planting of cucumber on the same day with maize for better protection of cucumber insect pests and enhanced yield.

Disclaimer (Artificial intelligence)

Author(s) hereby declares that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc.) and text-to-image generators have been used during the writing or editing of this manuscript.

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