

Comparative Efficacy of Spacing on Insect-Pests of Cucumber in Cucumber-Maize Intercropping System

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Abstract

Field trials were conducted in 2023 and 2024 planting seasons to evaluate the potency of spacing in intercropping cucumber with maize on the insect-pests and yield of cucumber in Calabar, Cross River State, Nigeria. The field trial was carried out in 2023 and then repeated the following year (2024). The experiment had the planting of cucumber with maize in an intercropping system using 3 spacings as thus; 75cm x75cm, 75cm x 50cm and 75cm X 25cm. Four varieties of cucumber namely; Mona Lisa, Murano 2, Nandini 732 and cucumber marketer while only ART - 98-SWI variety of maize was used in the experiment. The experiment was laid out in a Randomized Complete Block Design and treatments replicated 4 times. The major insect pests assessed in the field were; *Acalymma vittatum*, *Diabrotica undecimpunctata*, *Aulacophora* spp and *E. elaterii*. Data obtained were analyzed using Genstat 8.1 statistical software and significant ($P < 0.05$) means were separated using Tukey Honest significant method. The results of the findings showed that Cucumber-maize intercropping at 75cm X 25cm had reduced population density of all the insect pests when compared with other planting distances. The intercrop of Nandini 732, Mona Lisa and Murano 2 and cucumber marketer variety with maize at 75cm X 25cm had relatively reduced pest pressure and higher yield when compared with that of other spacings. In 2023 cropping season, the Nandini cucumber variety -maize intercrop at 75cm X 25cm had 44.79% increase in cucumber fruit yield (t/ha) when compared with that of 75cm x75cm while in 2024 season, Mona Lisa cucumber variety-maize intercrop at 75cm X 25cm had 56.51 % increase when compared with that of 75cm x75cm. The result suggests that intercropping of Cucumber with maize at 75cm X 25cm is more effective in the management of insect pests of cucumber and increase in fruit productivity of cucumber.

Keywords: Cucumber-Maize Intercropping, Planting Spacing, Insect Pests, Yield, Nigeria.

Introduction

Cucumber is one of the frost-sensitive and predominantly tendril-bearing vining plants that belongs to the family called Cucurbitaceae. It is the oldest vegetable cultivated by man, originated from India and are found in tropical and sub-tropical region around the globe (Bharadiya and Bhunt, 2017; Chakraborty *et al.*, 2019; Kumar *et al.*, 2021; Odewole *et al.*, 2020; Wehner *et al.*, 2020; Otie *et al.*, 2024). The fruit contains high level of vitamins, cucurbitacin and their derivatives (triperoids), flavonoids, antioxidants such as beta-carotenes among other trace elements and minerals (Adeoti *et al.*, 2024; Otie *et al.*, 2024).

Due to the increasing awareness of the importance of this crop, there is an increasing demand for its fruits (Kumar *et al.*, 2021; Wehner *et al.*, 2020) and as such require higher production for the crop to meet up with Man's demand. *Acalymma vittatum*, *Diabrotica undecimpunctata*, *Aulacophora* spp., *Epilachna elaterii* etc are some of the major insect pests of cucumber that results in high damage to the plant. 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). Intercropping enables efficient use of available resources to promote ecosystem services towards reducing pest pressure and harms of pesticides without sacrificing yields (Rodrigues *et al.*, 2018; Ullah *et al.*, 2020). Intercropping with maize had been largely successful in reducing the population of insect pests and increasing the yield of the companion crop (Pitan and Filani, 2014; Ju *et al.*, 2019; Li *et al.*, 2020; Fitcher *et al.*, 2020; Nassary *et al.*, 2020).

Problem statement

Among the biotic factors, the major limiting factor to the profitable production of cucumber is the extensive crop devastation owing to increase insect infestation (Umeh and Ojiako, 2018; Abo-Elmaged *et al.*, 2020; Awadalla *et al.*, 2020; Pongen *et al.*, 2021; Rivers *et al.*, 2024) which may even result in 100 percent yield loss due to the fact that some of them serve also as vectors of viral diseases (Shinde *et al.*, 2018; Mondal *et al.*, 2020). The popular use of synthetic pesticides to control the pests of this crop, has continue to pose huge health hazard to man and his environment (Ukatu *et al.*, 2024; Ugbe *et al.*, 2025). Despite intercropping being recommended by some researchers for the proper management of insect pests of cucumber (Pitan and Esan, 2013; Pitan and Filani, 2014), paucity of researches on the appropriate spacing required for effective management of the insect pests in intercropping cucumber with maize abound.

Research objectives and questions:

Objective: This study aimed to evaluate the effect of three plant spacings (75 cm × 75 cm, 75 cm × 50 cm, 75 cm × 25 cm) in cucumber–maize intercropping on (a) insect-pest population densities and (b) cucumber fruit yield across four cucumber cultivars in Calabar, Nigeria.

Research Questions:

1. Which plant spacing minimizes population density of major cucumber insect pests (*Acalymma vittatum*, *Diabrotica undecimpunctata*, *Aulacophora* spp., *Epilachna elaterii*)?
2. How does cucumber yield (t/ha) vary across the three spacings when intercropped with maize?

Materials and Methods

The experiment was laid in three set-ups with each of the experiment carried out in two seasons i.e., 2023 and 2024 respectively. 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 institute of Agricultural Research and training, Moor plantation, Ibadan. The 3 experimental setups made use of 4 varieties of cucumber and 1 variety of maize. The experiment was laid out in a Randomized Complete Block Design and replicated four times as thus.

The experiment involved cultivation of the four varieties of cucumber with maize in an intercropping system. The experiment had a total of 12 treatments that was replicated 4 times. Three spacing were used to evaluate their impact on the population density of insect pests on cucumber. The three spacing used included: 75cm x 75cm, 75cm x 50cm and 75cm x 25cm. A combination of a variety of cucumber intercropped with maize at a spacing gave rise to each treatment. The cucumber and maize were planted in alternate rows. Planting was carried out by September and March of 2023 and 2024, representing late and early planting seasons, respectively.

The total plot size used for this experiment was 67m x 23m (1,541m²). The plant population were 17,778 plants/ha for the spacing of 75cm x 75cm (i.e 8,889 each cucumber and maize), 26,667 plants/ha for 75cm x 50cm (i.e, 13,334 cucumber and maize each) and 53,333 plants/ha for 75cm x 25cm (26,667 plants for cucumber and maize each). Two cucumber and maize seeds, respectively were planted per hole on a bed into each plot and were later thinned to one seeding per hole, two weeks after planting (2 WAP). Manual weeding was carried out at 7days after planting (DAP) and subsequently once in every two weeks. There was no herbicide application or pesticide throughout the entire experiments (the three experiments). 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.

Data collection

Sampling was done at four weeks after planting (24days) and subsequently at 2 weekly intervals till fruit maturing between 7:00am- 9:00am when insects were relatively inactive. The population densities of cucumber beetles, pumpkin beetles and *Epilachna* beetles were obtained by visual counting of the insects on 6 randomly selected plants per plot in the middle rows of the plot.

Fruit yield: Undamaged fruits 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.

Data analysis

All data on insect population were transformed using square root transformation ($\sqrt{x+0.5}$) before subjecting to analysis of variance (ANOVA). Significant mean values were separated using Tukey Honest significant difference at 5% probability level.

Results

The effect of spacing in cucumber – maize intercropping system on the population of *Aulacophora* spp is shown in Table 1.

The result indicated that spacing in the intercropping of cucumber with maize had significant ($p<0.05$) effect on the population density of *Aulacophora* spp on cucumber plants both at the 2023 and 2024 planting seasons. At 4, 6, and 8 weeks after planting (WAP) in 2023 planting season, each of the cucumber variety, Mona Lisa (Va), Murano 2 (Vm), Nandini 732 (Vn) and cucumber marketer (Vo) intercropped with maize at a spacing of 75cm x 75cm, 75cm x 50cm and 75cm X 25cm (m_3) had varied population of *Aulacophora* on cucumber plants. At 4 and 8 WAP, the spacing of cucumber did not have significant difference on the population of *Aulacophora* within each variety of cucumber intercropped with maize except the intercrop of Murano 2 variety with maize at 4WAP using the spacing of 75cm X 25cm that had significant reduction in the population of *Aulacophora* spp when compared with the intercrop of maize associated with the same variety of cucumber at the spacing of 75cm X 75cm. Similarly, at 4 WAP, the Murano 2 variety intercropped with maize at the spacing of 75cm X 75cm had significantly ($P<0.05$) higher population of *Aulacophora* spp than that of cucumber marketer variety intercropped with maize at the same spacing of 75cm X 75cm while at 8WAP, the intercrop of Murano 2 variety at the spacing of 75cm X 75cm had significantly ($P<0.05$) higher population density of *Aulacophora* spp than the intercrop of Mona Lisa variety at the spacing of 75cm X 25cm. At 6 WAP, Cucumber marketer variety intercropped with maize using a spacing of 75cm X 75cm had significantly ($P<0.05$) higher number of *Aulacophora* spp on cucumber plants than the one with the spacing of 75cm X 50cm and 75cm X 25cm, respectively. Nandini 732 Variety of Cucumber intercropped with maize at the spacing of 75cm X 25cm had significantly ($P<0.05$) lower population of *Aulacophora* spp than that of 75cm X 75cm.

Similarly, each of Nandini 732 and cucumber marketer intercropped with maize at 75cm X 25 cm had significantly ($P<0.05$) lower number of *Aulacophora* spp than the ones planted at the spacing of 75cmX75cm, respectively.

At 4WAP in 2024 season, each of the intercrop of cucumber marketer variety and that of Nandini 732 with maize at the spacing of 75cm X 25cm had significantly ($P<0.05$) lower population density of *Aulacophora* spp than their respective intercrop with maze at 75cm X 50cm and 75cm X 75cm. Similarly, the intercrop of Murano 2 variety of cucumber with maize at 75cm X 25cm had significantly ($P<0.05$) lower population density of *Aulacophora* spp than that of 75cm X 75cm. Among the variety used for the intercropping, the intercrop of Murano 2 variety at 4WAP had significantly ($P<0.05$) lower population of *Aulacophora* spp than that of Mona Lisa variety at the same spacing of 75cm X 25cm.

At 6WAP, spacing in intercropping cucumber-maize have significant effect on *Aulacophora* spp population within any given variety except the intercropping of cucumber marketer variety at the spacing of 75cm X 25cm that had significantly ($P < 0.05$) reduced population of *Aulacophora* spp when compared with the intercrop at 75cm X 50cm and 75cm X 75cm, respectively. There was no significant ($P > 0.05$) difference in *Aulacophora* spp population among the varieties of cucumber intercropped at the same spacing with maize.

At 8WAP, only the intercrop of Mona Lisa variety of cucumber at 75cm X 25cm was significantly ($P < 0.05$) lower in population density of *Aulacophora* spp than its spacing at 75cm X 50cm and 75cm X 75cm, respectively. Other varieties did not show significant ($P > 0.05$) difference in *Aulacophora* spp population in response to different spacing.

The effect of spacing in cucumber – maize intercropping system on the population of *Acalymma vittatum* is shown in Table 2.

The result showed that spacing in intercropping of cucumber with maize had significant difference ($P < 0.05$) on the population of *A. vittatum* both in 2023 and 2024 planting seasons. At 4 WAP, in 2023 there was no significant ($P < 0.05$) difference in the population of *A. vittatum* across the treatment, hence spacing did not have effect on the population of *A. vittatum*. At 6 WAP in 2023 planting season, spacing in the cucumber – maize intercrop only had significant ($P < 0.05$) difference in *A. vittatum* population density when cucumber variety was compared with another variety but did not show significant ($P > 0.05$) when compared within a given variety. The intercrop of Murano 2 variety with maize at the spacing of 75cm X 75cm had significantly ($P < 0.05$) higher population density of when compared with that of Nandini 732 and Cucumber marketer variety intercrop at the spacing of 75cm X 25cm, respectively. At 8WAP, the intercrop of Murano 2 variety with maize at 75cm X 25cm had significantly ($P < 0.05$) lower population density of *A. vittatum* than that of its spacing at 75cm X 75cm. The population density of *A. vittatum* when Murano 2 variety was intercropped with maize at 75cm X 75cm had significantly ($P < 0.05$) higher *A. vittatum* than that of Nandini 732 variety intercropped with maize at the same spacing of 75cm X 75cm.

In 2024, at 4 WAP, the intercrop of all the varieties of cucumber with maize at 75cm X 25cm had significantly ($P < 0.05$) lower population of *A. vittatum* than their respective intercrop at the spacing of 75cm X 75cm except the intercrop of Murano 2 variety at 75cm X 50cm had significantly ($P < 0.05$) lower population of *A. vittatum* than its intercrop at the spacing of 75cm X 75cm.

At 6WAP, the intercrop of all the varieties of cucumber with maize at the spacing of 75cm X 75cm had significantly ($P < 0.05$) higher number of *A. vittatum* on cucumber than its respective intercrop at the spacing of 75cm X 25cm. The cucumber –maize intercrop of Murano 2 and Cucumber marketer variety at the spacing of 75cm X 50cm had significantly ($P < 0.05$) lower *A. vittatum* population than that of their respective spacing at 75cm X 75cm. The intercrop of Murano 2 variety at 75cm X 50cm with maize had significantly ($P < 0.05$) higher number of *A. vittatum* than the intercrop of other varieties with maize at the same spacing of 75cm X 50cm.

At 8WAP, only the intercrop of Murano 2 variety with maize at the spacing of 75cm X 25cm had significantly ($P < 0.05$) lower population density of *A. vittatum* than its spacing of 75cm X 75cm while no significant ($P > 0.05$) difference exist in spacing within any other varieties in reference to *A. vittatum*

The effect of spacing in cucumber- maize intercropping system on the population of *D. undecimpunctata* (spotted cucumber beetle) is shown in Table 3.

The result showed that spacing in intercropping of cucumber with maize had significant ($p < 0.05$) effect on the population of *D. undecimpunctata* in both years (2023 and 2024 planting season). At 4WAP in 2023, spacing did not have any significant difference ($p < 0.05$) in the population of *D. undecimpunctata* within a variety while at the same stage in 2024, there was significant difference in the population of *D. undecimpunctata* arising from the intercropping of cucumber variety with maize at various spacing. At 4WAP, in 2024, all the varieties of cucumber intercropped with maize at 75cm x 25 cm had significantly ($p < 0.05$) lower population of *D. undecimpunctata* when compared with that of its 75cm x 75cm except the intercrop of Mona Lisa variety with maize which the spacing at 75cm x 25cm was statistically ($p < 0.05$) at par with that of 75cm x 75cm. The intercrop of Murano 2 and Nandini 732 with maize at 75cm X 50cm had significantly ($P < 0.05$) lower population density when compared with its spacing at 75cm X 75cm. All the intercrop of various varieties of cucumber at the same spacing were statistically ($P > 0.05$) at par in regards to the population density of *D. undecimpunctata* in both years. At 6WAP, the intercropping of Murano 2 variety with maize at 75cm x 75cm in 2023 and 2024 planting seasons had significantly ($p < 0.05$) higher population of *D. undecimpunctata* than that at 75cm x 25cm. Similarly, Cucumber marketer intercropped with maize at the spacing of 75cm x 75cm had significantly ($p < 0.05$) higher number of *D. undecimpunctata* than that of 75cm x 25cm at 6WAP during the 2023 planting season. All the varieties intercropped with maize at the same spacing did not have significant ($P > 0.05$) difference in the population density of *D. undecimpunctata* at 6WAP in both years. At 8WAP in 2023, there was no significant ($p > 0.05$) difference in the population of *D. undecimpunctata* owing to the spacing of cucumber intercropped with maize while at the same stage in 2024, Murano 2 had significantly ($p < 0.05$) lower population of *D. undecimpunctata* at the spacing of 75cm x 25cm when compared with the spacing of 75cm x 75cm and 75cm x 5cm, respectively. Also, there was no significant ($P > 0.05$) difference among varieties used in intercropping at the same spacing in terms of *D. undecimpunctata* population.

The effect of spacing in cucumber-maize intercropping system on the population of *E. elaterii* is shown in Table 4.

The result showed that spacing in the intercropping of cucumber with maize had significant ($p < 0.05$) effect on the population of *E. elaterii* in both, 2023 and 2024 planting seasons.

At 4WAP in both years (2023 and 2024), spacing did not have significant difference among the treatments in cucumber-maize intercropping system with reference to *E. elaterii* population density. However, at 6WAP in 2023, spacing had significant ($p < 0.05$) difference among the treatments in cucumber-maize intercropping in regards to the population density of *E. elaterii* while at the same stage in 2024, spacing did not have significant

($p > 0.05$) difference on the population of *E. elaterii* when cucumbers were intercropped with maize. The intercrop of Nandini 732 with maize at the spacing of 75cm X 25cm had significantly ($p < 0.05$) lower population density of *E. elaterii* when compared with its spacing of 75cm X 75cm at 6WAP in 2023.

Furthermore, at 8WAP in 2023, spacing did not have significant ($p < 0.05$) difference in the intercropping of cucumber with maize on the population density of *E. elaterii* while spacing had significant ($p < 0.05$) difference in the intercropping of cucumber with maize at the same stage (8WAP) in 2024. The intercropping of cucumber marketer with maize at 75cm X 25cm had significantly ($p < 0.05$) reduced population density of *E. elaterii* than its spacing at 75cm X 75cm and 75cm X 50cm, respectively in 2024. Similarly, the intercropping of Nandini 732 variety with maize at the spacing of 75cm X 75cm had significantly ($p < 0.05$) lower population density of *E. elaterii* than that of its spacing at 75cm X 50cm.

The effect of spacing in cucumber-maize intercropping system on fruit yield of cucumber is shown in Table 5.

The result showed that spacing in the cucumber-maize intercropping had significant ($P < 0.05$) effect on the fruit yield of cucumber. In both years (2023 and 2024), the intercropping of all the varieties used in this experiment at 75cm x 75cm and 75cm x 50cm had significantly ($P < 0.05$) lower yield (Kg/plot) of the fruits than the spacing of cucumber intercropped with maize at the spacing of 75cm x 25cm. The yield (kg/plot) obtained from Nandini 732 variety was significantly ($P < 0.05$) higher than that of Cucumber marketer variety at the same spacing of 75cm X 75cm and 75cm X 50cm, respectively in 2023. In 2024, the fruit yield (Kg/plot) from cucumber marketer was significantly ($P < 0.05$) lower than that of Nandini 732, Murano 2 and Mona Lisa variety.

In 2023, intercrop of all the varieties used in the experiment at 75cm X 25cm had significantly ($P < 0.05$) higher fruit yield (t/ha) than that of 75cm X 75cm and 75cm X 50cm, respectively except the intercrop of cucumber marketer variety that the spacing at 75cm X 25cm was only significantly ($P < 0.05$) higher than the spacing at 75cm X 75cm. Nandini 732 had significantly ($P < 0.05$) higher fruit yield (t/ha) than that of cucumber marketer variety when both were intercropped at the spacing of 75cm X 75cm.

In 2024, the intercrop of all cucumber varieties at the spacing of 75cm X 25cm had significantly ($P < 0.05$) higher fruit yield (t/ha) of cucumber than its spacing at 75cm X 75cm. Also, the intercrop of Nandini 732 and Murano 2 variety at 75cm X 50cm had significantly ($P < 0.05$) higher fruit yield (t/ha) when compared with their respective spacing of 75cm X 75cm. Mona Lisa intercrop had significantly ($P < 0.05$) higher fruit yield (t/ha) than that of cucumber marketer when both were intercropped at the spacing of 75cm X 25cm. The effect of Cucumber-maize intercropping on the insect pests and yield of cucumber is shown in Figure 1-5.

Table 1: Effect of Spacing in Cucumber – Maize Intercropping System on the Population of *Aulacophora spp*

TREATMENT	2023			2024		
	4WAP	6WAP	8WAP	4WAP	6WAP	8WAP
VaM ₁	1.70±0.05 ^{ab}	1.72±0.09 ^a	1.33±0.22 ^{ab}	1.20±0.05 ^a	1.37±0.09 ^a	1.15±0.22 ^a
VaM ₂	1.66±0.13 ^{ab}	1.60±0.11 ^{ab}	1.33±0.21 ^{ab}	1.04±0.13 ^{abc}	1.32±0.11 ^{ab}	1.17±0.21 ^a
VaM ₃	1.41±0.08 ^{abc}	1.29±0.06 ^{abc}	0.93±0.09 ^b	0.93±0.08 ^{ab}	1.13±0.06 ^{abc}	0.81±0.09 ^b
VmM ₁	1.87±0.02 ^a	1.74±0.08 ^a	1.67±0.08 ^a	1.10±0.02 ^{ab}	1.35±0.08 ^a	1.26±0.08 ^a
VmM ₂	1.63±0.16 ^{ab}	1.63±0.02 ^a	1.45±0.04 ^{ab}	1.05±0.16 ^{abc}	1.31±0.02 ^{ab}	1.22±0.04 ^a
VmM ₃	1.25±0.19 ^{bc}	1.42±0.12 ^{abc}	1.16±0.17 ^{ab}	0.77±0.19 ^c	1.15±0.12 ^{abc}	1.10±0.17 ^{ab}
VnM ₁	1.42±0.08 ^{abc}	1.63±0.07 ^a	1.58±0.14 ^{ab}	1.18±0.08 ^a	1.28±0.07 ^{abc}	1.07±0.14 ^{ab}
VnM ₂	1.52±0.04 ^{abc}	1.53±0.05 ^{abc}	1.45±0.18 ^{ab}	1.19±0.04 ^a	1.33±0.05 ^{ab}	1.05±0.18 ^{ab}
VnM ₃	1.07±0.12 ^e	1.13±0.04 ^{bc}	1.05±0.20 ^{ab}	0.85±0.12 ^{bc}	1.07±0.04 ^{bc}	0.81±0.20 ^b
VoM ₁	1.33±0.09 ^{bc}	1.63±0.16 ^a	1.73±0.11 ^a	1.20±0.09 ^a	1.34±0.16 ^{ab}	1.28±0.11 ^a
VoM ₂	1.29±0.10 ^{bc}	1.10±0.14 ^c	1.63±0.10 ^{ab}	1.24±0.10 ^a	1.32±0.14 ^{ab}	1.31±0.10 ^a
VoM ₃	1.04±0.14 ^c	1.04±0.14 ^c	1.23±0.01 ^{ab}	0.85±0.14 ^{bc}	1.04±0.14 ^c	1.04±0.06 ^{ab}
SED	0.15	0.14	0.20	0.09	0.08	0.08
COV(%)	15	13.7	20.8	11.8	8.7	10.4

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:

VaM₁: Intercrop of Mona Lisa variety of cucumber with maize at the spacing of 75cm X 75cm

VaM₂: Intercrop of Mona Lisa variety of cucumber with maize at the spacing of 75cm X 50cm

VaM₃: Intercrop of Mona Lisa variety of cucumber with maize at the spacing of 75cm X 25cm

VmM₁: Intercrop of Murano variety of cucumber with maize at the spacing of 75cm X 75cm

VmM₂: Intercrop of Murano variety of cucumber with maize at the spacing of 75cm X 50cm

VmM₃: Intercrop of Murano variety of cucumber with maize at the spacing of 75cm X 25cm

VnM₁: Intercrop of Nandini variety of cucumber with maize at the spacing of 75cm X 75cm

VnM₂: Intercrop of Nandini variety of cucumber with maize at the spacing of 75cm X 50cm

VnM₃: Intercrop of Nandini variety of cucumber with maize at the spacing of 75cm X 25cm

VoM₁: Intercrop of cucumber marketer variety with maize at the spacing of 75cm X 75cm

VoM₂: Intercrop of cucumber marketer variety with maize at the spacing of 75cm X 50cm

VoM₃: Intercrop of cucumber marketer variety with maize at the spacing of 75cm X 25cm

SED: Standard Error of Difference of Means

COV: Co-efficient of Variability

Table 2: Effect of Spacing in Cucumber – Maize Intercropping System on the Population of *Acalymma vittatum*

TREATMENT	2023			2024		
	4WAP	6WAP	8WAP	4WAP	6WAP	8WAP
VaM ₁	1.19±0.07 ^a	1.39±0.09 ^{ab}	1.19±0.13 ^{ab}	1.12±0.12 ^{bcd}	1.07±0.06 ^{de}	0.97±0.09 ^{abc}
VaM ₂	1.00±0.10 ^a	1.22±0.18 ^{ab}	1.11±0.06 ^{ab}	1.14±0.08 ^{bcd}	1.05±0.08 ^{def}	0.98±0.04 ^{abc}
VaM ₃	0.86±0.08 ^a	0.98±0.16 ^{ab}	0.91±0.07 ^b	0.76±0.05 ^e	0.77±0.03 ^f	0.74±0.03 ^{bc}
VmM ₁	1.35±0.21 ^a	1.59±0.20 ^a	1.47±0.04 ^a	1.77±0.04 ^a	1.71±0.01 ^a	1.25±0.06 ^a
VmM ₂	0.99±0.06 ^a	1.45±0.25 ^{ab}	1.23±0.09 ^{ab}	1.75±0.09 ^a	1.73±0.05 ^a	1.19±0.04 ^{ab}
VmM ₃	0.81±0.06 ^a	1.17±0.13 ^{ab}	1.05±0.06 ^b	0.85±0.09 ^{de}	1.25±0.03 ^{bcd}	0.93±0.05 ^c
VnM ₁	1.32±0.20 ^a	1.14±0.10 ^{ab}	1.07±0.07 ^b	1.03±0.08 ^{bcd}	1.22±0.06 ^{bcd}	0.91±0.04 ^{abc}
VnM ₂	1.24±0.14 ^a	1.16±0.10 ^{ab}	1.02±0.05 ^b	1.00±0.04 ^{cde}	1.08±0.13 ^{cde}	0.88±0.09 ^{abc}
VnM ₃	1.05±0.15 ^a	0.91±0.10 ^b	0.88±0.06 ^b	0.76±0.05 ^e	0.85±0.04 ^{ef}	0.74±0.03 ^{abc}
VoM ₁	1.39±0.24 ^a	1.45±0.10 ^{ab}	1.24±0.14 ^{ab}	1.35±0.02 ^b	1.38±0.02 ^b	1.27±0.03 ^{abc}
VoM ₂	1.16±0.19 ^a	1.24±0.10 ^{ab}	1.09±0.06 ^b	1.34±0.06 ^{bc}	1.37±0.06 ^{bc}	1.29±0.03 ^{ab}
VoM ₃	0.94±0.09 ^a	0.83±0.07 ^b	0.93±0.02 ^b	0.99±0.08 ^{de}	0.98±0.04 ^{def}	0.93±0.05 ^{abc}
SED	0.20	0.20	0.11	0.10	0.06	0.07
COV (%)	25	22.8	13.6	11.9	10%	10.4

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

Keys:

VaM₁: Intercrop of Mona Lisa variety of cucumber with maize at the spacing of 75cm X 75cm

VaM₂: Intercrop of Mona Lisa variety of cucumber with maize at the spacing of 75cm X 50cm

VaM₃: Intercrop of Mona Lisa variety of cucumber with maize at the spacing of 75cm X 25cm

VmM₁: Intercrop of Murano variety of cucumber with maize at the spacing of 75cm X 75cm

VmM₂: Intercrop of Murano variety of cucumber with maize at the spacing of 75cm X 50cm

VmM₃: Intercrop of Murano variety of cucumber with maize at the spacing of 75cm X 25cm

VnM₁: Intercrop of Nandini variety of cucumber with maize at the spacing of 75cm X 75cm

VnM₂: Intercrop of Nandini variety of cucumber with maize at the spacing of 75cm X 50cm

VnM₃: Intercrop of Nandini variety of cucumber with maize at the spacing of 75cm X 25cm

VoM₁: Intercrop of cucumber marketer variety with maize at the spacing of 75cm X 75cm

VoM₂: Intercrop of cucumber marketer variety with maize at the spacing of 75cm X 50cm

VoM₃: Intercrop of cucumber marketer variety with maize at the spacing of 75cm X 25cm

SED: Standard Error of Difference of Means

COV: Co-efficient of Variability

Table 3: Effect of Spacing in Cucumber – Maize Intercropping System on the Population of *Diabrotica undecimpunctata*

TREATMENT	2023			2024		
	4WAP	6WAP	8WAP	4WAP	6WAP	8WAP
VaM ₁	1.37±0.13 ^{ab}	1.41±0.14 ^{ab}	1.13±0.05 ^a	1.30±0.05 ^{ab}	1.27±0.05 ^{abc}	1.40±0.07 ^{abc}
VaM ₂	1.21±0.088 ^{ab}	1.21±0.11 ^{abc}	1.04±0.04 ^a	1.22±0.03 ^{abc}	1.22±0.05 ^{abc}	1.38±0.02 ^{abc}
VaM ₃	1.10±0.016 ^{ab}	0.91±0.07 ^{bc}	0.81±0.06 ^a	0.94±0.11 ^{bc}	0.97±0.06 ^{bc}	0.91±0.12 ^{bc}
VmM ₁	1.62±0.05 ^a	1.58±0.07 ^a	1.14±0.09 ^a	1.58±0.10 ^a	1.51±0.08 ^a	1.49±0.03 ^a
VmM ₂	1.42±0.05 ^{ab}	1.32±0.12 ^{abc}	1.11±0.14 ^a	1.59±0.07 ^a	1.39±0.13 ^{ab}	1.46±0.10 ^{ab}
VmM ₃	1.09±0.06 ^{ab}	1.07±0.15 ^{bc}	0.91±0.07 ^a	1.00±0.12 ^{bc}	0.92±0.09 ^c	0.89±0.12 ^c
VnM ₁	1.19±0.13 ^{ab}	1.13±0.05 ^{abc}	1.00±0.10 ^a	1.38±0.06 ^{ab}	1.27±0.14 ^{abc}	1.29±0.15 ^{abc}
VnM ₂	1.15±0.14 ^{ab}	1.08±0.11 ^{abc}	0.93±0.07 ^a	1.35±0.02 ^{ab}	1.35±0.05 ^{abc}	1.33±0.04 ^{abc}
VnM ₃	0.88±0.06 ^b	0.88±0.06 ^c	0.83±0.07 ^a	0.79±0.21 ^c	1.00±0.12 ^{bc}	0.99±0.06 ^{abc}
VoM ₁	1.41±0.16 ^{ab}	1.59±0.09 ^a	1.21±0.15 ^a	1.50±0.06 ^a	1.46±0.03 ^a	1.38±0.14 ^{abc}
VoM ₂	1.23±0.11 ^{ab}	1.39±0.14 ^{ab}	1.18±0.07 ^a	1.41±0.11 ^{ab}	1.47±0.05 ^a	1.46±0.11 ^{ab}
VoM ₃	1.06±0.06 ^b	1.02±0.05 ^{bc}	0.91±0.07 ^a	0.98±0.11 ^{bc}	1.10±0.11 ^{abc}	1.13±0.19 ^{abc}
SED	0.16	0.14	0.12	0.14	0.12	0.16
COV(%)	17.9	16.8	16.6	15.5	14.2	17.9

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:

VaM₁: Intercrop of Mona Lisa variety of cucumber with maize at the spacing of 75cm X 75cm

VaM₂: Intercrop of Mona Lisa variety of cucumber with maize at the spacing of 75cm X 50cm

VaM₃: Intercrop of Mona Lisa variety of cucumber with maize at the spacing of 75cm X 25cm

VmM₁: Intercrop of Murano variety of cucumber with maize at the spacing of 75cm X 75cm

VmM₂: Intercrop of Murano variety of cucumber with maize at the spacing of 75cm X 50cm

VmM₃: Intercrop of Murano variety of cucumber with maize at the spacing of 75cm X 25cm

VnM₁: Intercrop of Nandini variety of cucumber with maize at the spacing of 75cm X 75cm

VnM₂: Intercrop of Nandini variety of cucumber with maize at the spacing of 75cm X 50cm

VnM₃: Intercrop of Nandini variety of cucumber with maize at the spacing of 75cm X 25cm

VoM₁: Intercrop of cucumber marketer variety with maize at the spacing of 75cm X 75cm

VoM₂: Intercrop of cucumber marketer variety with maize at the spacing of 75cm X 50cm

VoM₃: Intercrop of cucumber marketer variety with maize at the spacing of 75cm X 25cm

SED: Standard Error of Difference of Means

COV: Co-efficient of Variability

Table 4: Effect of Spacing in Cucumber – Maize Intercropping System on the Population of *Epilachna elaterii*

TREATMENT	2023			2024		
	4WAP	6WAP	8WAP	4WAP	6WAP	8WAP
VaM ₁	1.00±0.10 ^a	1.09±0.09 ^{ab}	1.17±0.02 ^a	1.30±0.16 ^a	1.48±0.07 ^a	1.44±0.05 ^{ab}
VaM ₂	1.00±0.10 ^a	1.09±0.15 ^{ab}	1.18±0.07 ^a	1.20±0.15 ^a	1.43±0.14 ^a	1.39±0.06 ^{abc}
VaM ₃	0.81±0.05 ^a	0.86±0.07 ^{ab}	0.88±0.07 ^a	1.03±0.03 ^a	1.16±0.11 ^a	1.11±0.11 ^{bc}
VmM ₁	1.09±0.15 ^a	1.14±0.09 ^{ab}	1.12±0.15 ^a	1.49±0.05 ^a	1.50±0.04 ^a	1.53±0.04 ^a
VmM ₂	1.07±0.15 ^a	1.11±0.06 ^{ab}	1.16±0.15 ^a	1.50±0.05 ^a	1.41±0.03 ^a	1.43±0.03 ^{ab}
VmM ₃	0.86±0.07 ^a	0.88±0.06 ^{ab}	0.86±0.07 ^a	1.09±0.14 ^a	1.07±0.14 ^a	1.24±0.14 ^{abc}
VnM ₁	1.02±0.13 ^a	1.21±0.09 ^a	1.10±0.10 ^a	1.47±0.05 ^a	1.49±0.03 ^a	1.41±0.06 ^{abc}
VnM ₂	0.98±0.11 ^a	1.03±0.07 ^{ab}	1.14±0.10 ^a	1.49±0.03 ^a	1.47±0.02 ^a	1.45±0.05 ^{ab}
VnM ₃	0.83±0.07 ^a	0.78±0.07 ^b	0.88±0.06 ^a	1.27±0.15 ^a	1.09±0.11 ^a	1.04±0.15 ^c
VoM ₁	1.05±0.14 ^a	1.07±0.07 ^{ab}	1.32±0.13 ^a	1.44±0.06 ^a	1.48±0.09 ^a	1.48±0.05 ^a
VoM ₂	1.06±0.06 ^a	1.02±0.05 ^{ab}	1.26±0.09 ^a	1.38±0.04 ^a	1.43±0.04 ^a	1.47±0.06 ^{ab}
VoM ₃	0.83±0.05 ^a	0.86±0.03 ^{ab}	0.96±0.06 ^a	1.03±0.07 ^a	1.09±0.07 ^a	1.05±0.06 ^c
SED	0.15	0.12	0.14	0.15	0.14	0.11
COV(%)	21.50	17.1	18.1	16.4	15	11.30

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:

VaM₁: Intercrop of Mona Lisa variety of cucumber with maize at the spacing of 75cm X 75cm

VaM₂: Intercrop of Mona Lisa variety of cucumber with maize at the spacing of 75cm X 50cm

VaM₃: Intercrop of Mona Lisa variety of cucumber with maize at the spacing of 75cm X 25cm

VmM₁: Intercrop of Murano variety of cucumber with maize at the spacing of 75cm X 75cm

VmM₂: Intercrop of Murano variety of cucumber with maize at the spacing of 75cm X 50cm

VmM₃: Intercrop of Murano variety of cucumber with maize at the spacing of 75cm X 25cm

VnM₁: Intercrop of Nandini variety of cucumber with maize at the spacing of 75cm X 75cm

VnM₂: Intercrop of Nandini variety of cucumber with maize at the spacing of 75cm X 50cm

VnM₃: Intercrop of Nandini variety of cucumber with maize at the spacing of 75cm X 25cm

VoM₁: Intercrop of cucumber marketer variety with maize at the spacing of 75cm X 75cm

VoM₂: Intercrop of cucumber marketer variety with maize at the spacing of 75cm X 50cm

VoM₃: Intercrop of cucumber marketer variety with maize at the spacing of 75cm X 25cm

SED: Standard Error of Difference of Means

COV: Co-efficient of Variability

Table 5: Effect of Spacing in Cucumber – Maize Intercropping System on Fruit Yield of Cucumber

TREATMENT	Fruit Yield (Kg/plot) 2023	Fruit Yield (Kg/plot) 2024	Fruit Yield (t/ha) 2023	Fruit Yield (t/ha) 2024
VaM ₁	5.20±0.36 ^{abc}	5.66±0.13 ^a	11.55±0.79 ^{fg}	12.56±0.29 ^{ef}
VaM ₂	5.55±0.20 ^{ab}	5.59±0.15 ^a	18.49±0.66 ^{abcde}	18.63±0.49 ^{cd}
VaM ₃	3.32±0.18 ^{de}	4.33±0.53 ^b	22.15±1.17 ^{ab}	28.88±3.54 ^a
VmM ₁	5.23±0.28 ^{abc}	5.44±0.10 ^a	11.62±0.62 ^{fg}	12.07±0.12 ^f
VmM ₂	5.25±0.09 ^{abc}	5.44±0.17 ^a	17.51±0.31 ^{bcde}	18.14±0.57 ^{cde}
VmM ₃	3.28±0.21 ^{de}	4.00±0.20 ^{bc}	21.88±1.42 ^{abc}	26.65±1.35 ^a
VnM ₁	6.03±0.26 ^a	6.07±0.09 ^a	13.40±0.59 ^{efg}	13.49±0.19 ^{def}
VnM ₂	5.84±0.40 ^a	6.21±0.14 ^a	19.48±1.33 ^{abcd}	20.20±0.42 ^{bc}
VnM ₃	3.64±0.26 ^{de}	3.91±0.04 ^{bc}	24.27±1.73 ^a	25.80±0.12 ^{ab}
VoM ₁	4.18±0.34 ^{cd}	4.24±0.21 ^b	9.29±0.76 ^g	9.68±0.52 ^f
VoM ₂	4.43±0.24 ^{bcd}	4.39±0.12 ^b	14.76±0.80 ^{defg}	14.44±0.47 ^{cdef}
VoM ₃	2.42±0.37 ^e	3.15±0.13 ^c	16.13±2.44 ^{cdef}	19.94±1.84 ^{bc}
SED	0.37	0.26	1.67	1.72
COV(%)	11.5	7.6	14.2	13.20

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:

VaM₁: Intercrop of Mona Lisa variety of cucumber with maize at the spacing of 75cm X 75cm

VaM₂: Intercrop of Mona Lisa variety of cucumber with maize at the spacing of 75cm X 50cm

VaM₃: Intercrop of Mona Lisa variety of cucumber with maize at the spacing of 75cm X 25cm

VmM₁: Intercrop of Murano variety of cucumber with maize at the spacing of 75cm X 75cm

VmM₂: Intercrop of Murano variety of cucumber with maize at the spacing of 75cm X 50cm

VmM₃: Intercrop of Murano variety of cucumber with maize at the spacing of 75cm X 25cm

VnM₁: Intercrop of Nandini variety of cucumber with maize at the spacing of 75cm X 75cm

VnM₂: Intercrop of Nandini variety of cucumber with maize at the spacing of 75cm X 50cm

VnM₃: Intercrop of Nandini variety of cucumber with maize at the spacing of 75cm X 25cm

VoM₁: Intercrop of cucumber marketer variety with maize at the spacing of 75cm X 75cm

VoM₂: Intercrop of cucumber marketer variety with maize at the spacing of 75cm X 50cm

VoM₃: Intercrop of cucumber marketer variety with maize at the spacing of 75cm X 25cm

SED: Standard Error of Difference of Means

COV: Co-efficient of Variability

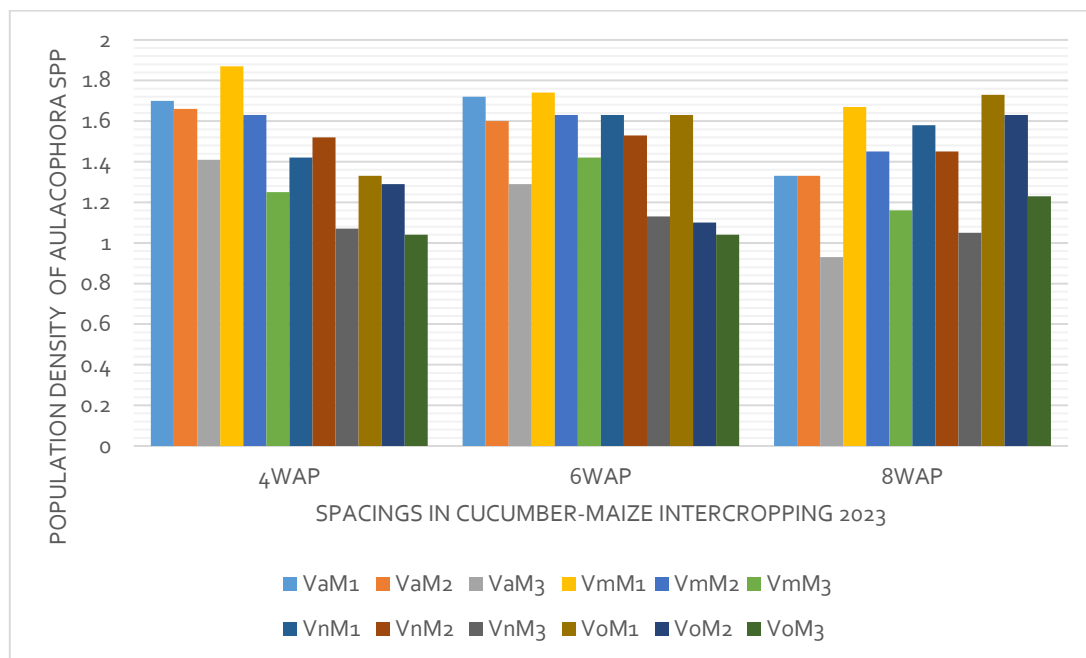


FIGURE 1(a):

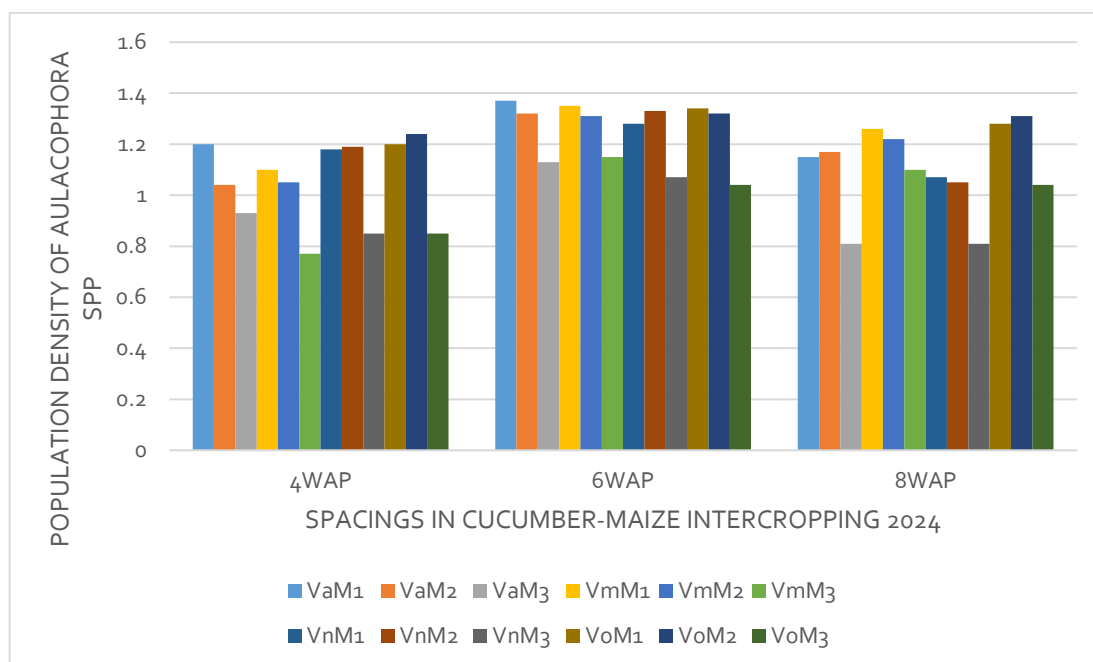


FIGURE 1(b):

FIGURE 1 (a) and (b): POPULATION DENSITIES OF *Aulacophora* spp ON CUCUMBER IN CUCUMBER-MAIZE SPACINGS

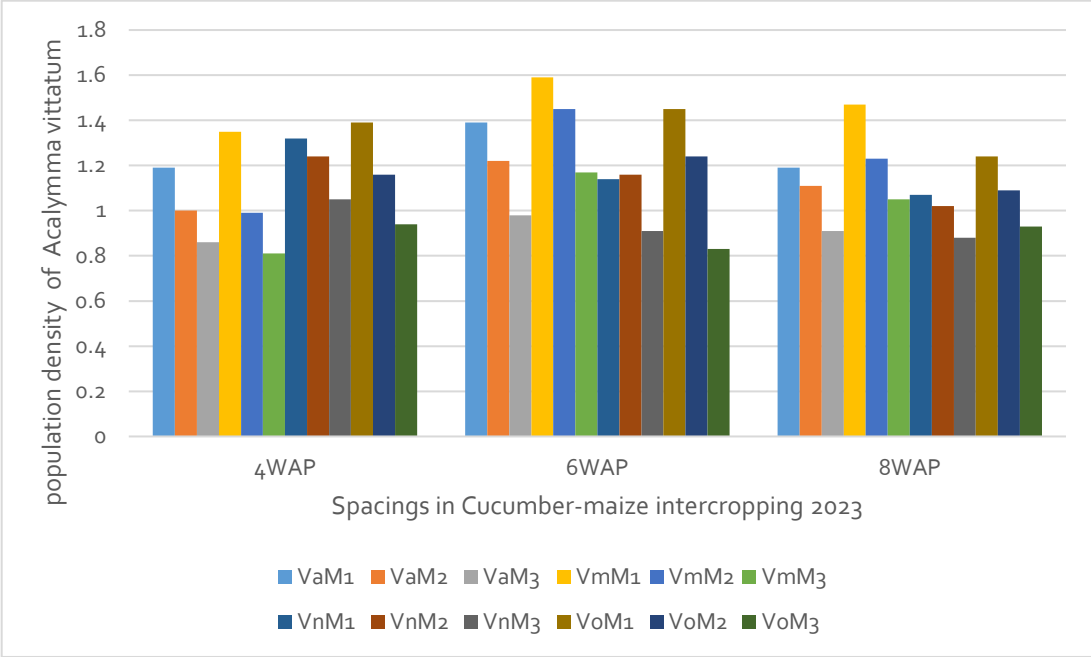


FIGURE 2 (a):

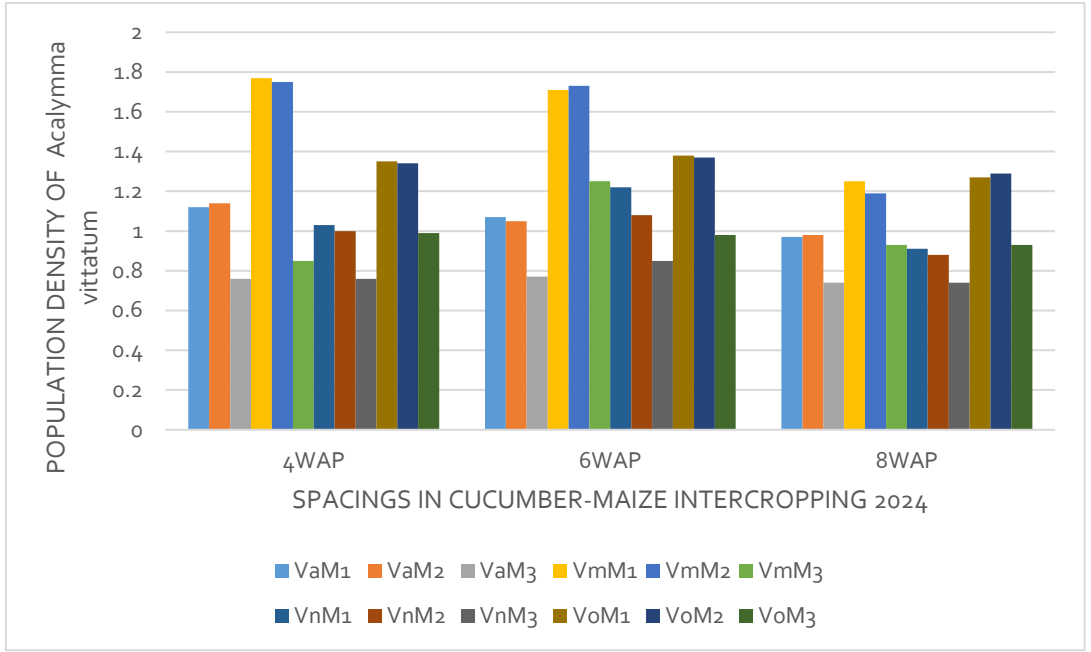


FIGURE 2 (a):

FIGURE 2: (a) and (b): POPULATION DENSITIES OF *Acalymma vittatum* ON CUCUMBER IN CUCUMBER-MAIZE SPACINGS

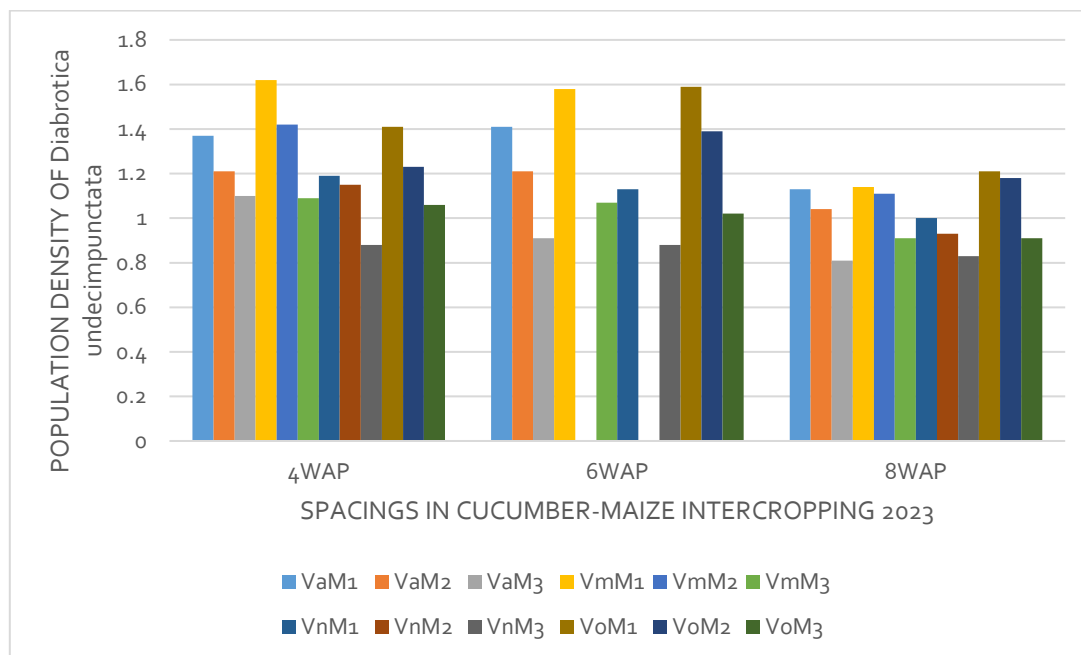


FIGURE 3 (a):

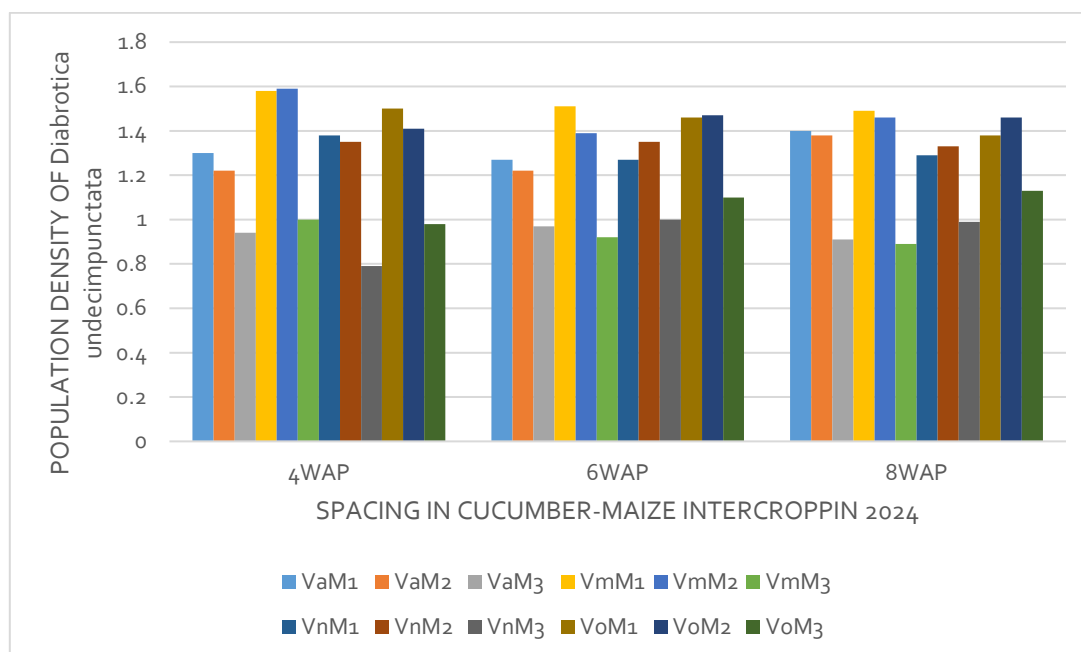


FIGURE 3 (b):

FIGURE 3: (a) and (b): POPULATION DENSITIES OF *Diabrotica undecimpunctata* ON CUCUMBER IN CUCUMBER-MAIZE SPACINGS

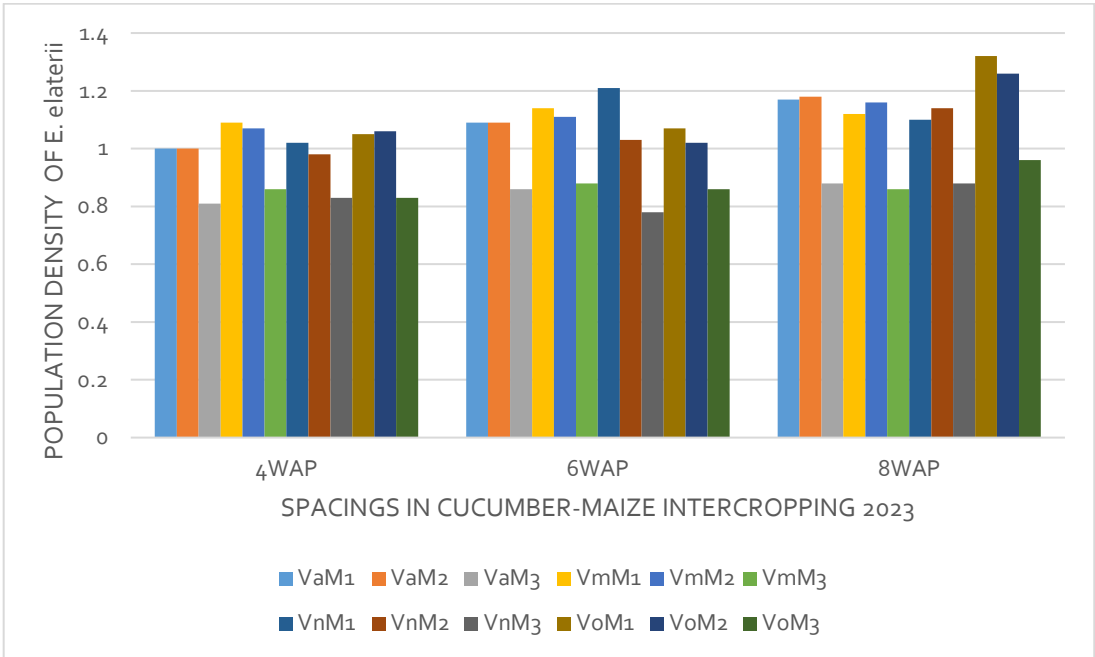


FIGURE 4 (a):

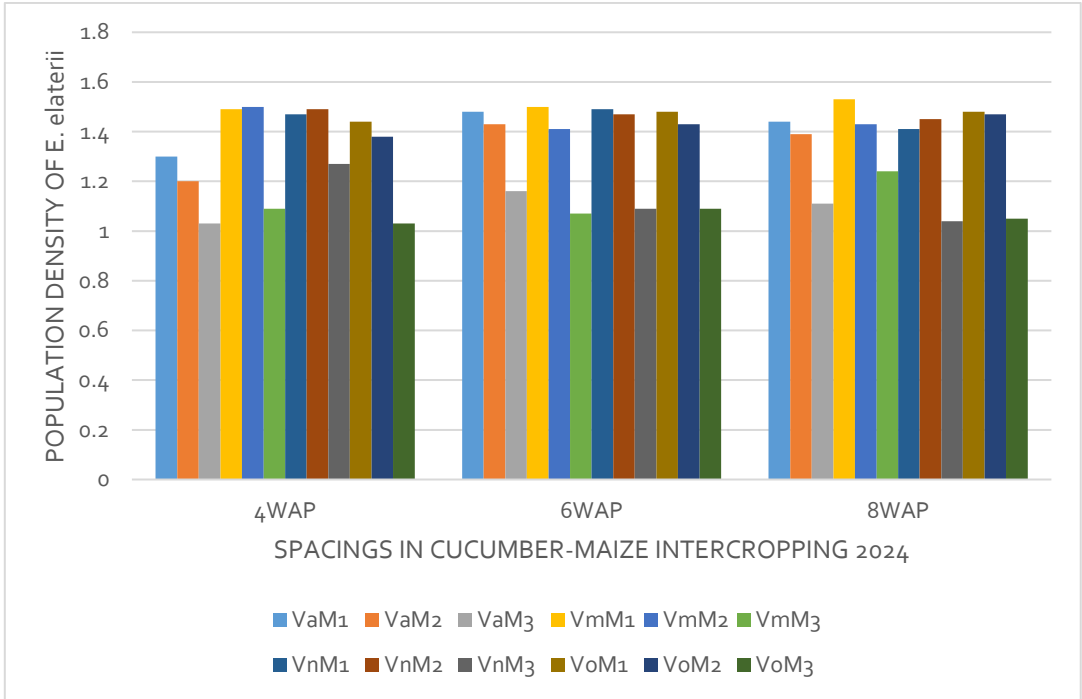


FIGURE 4(a):

FIGURE 4: (a) and (b): POPULATION DENSITIES OF *E. elaterii* ON CUCUMBER IN CUCUMBER-MAIZE SPACINGS

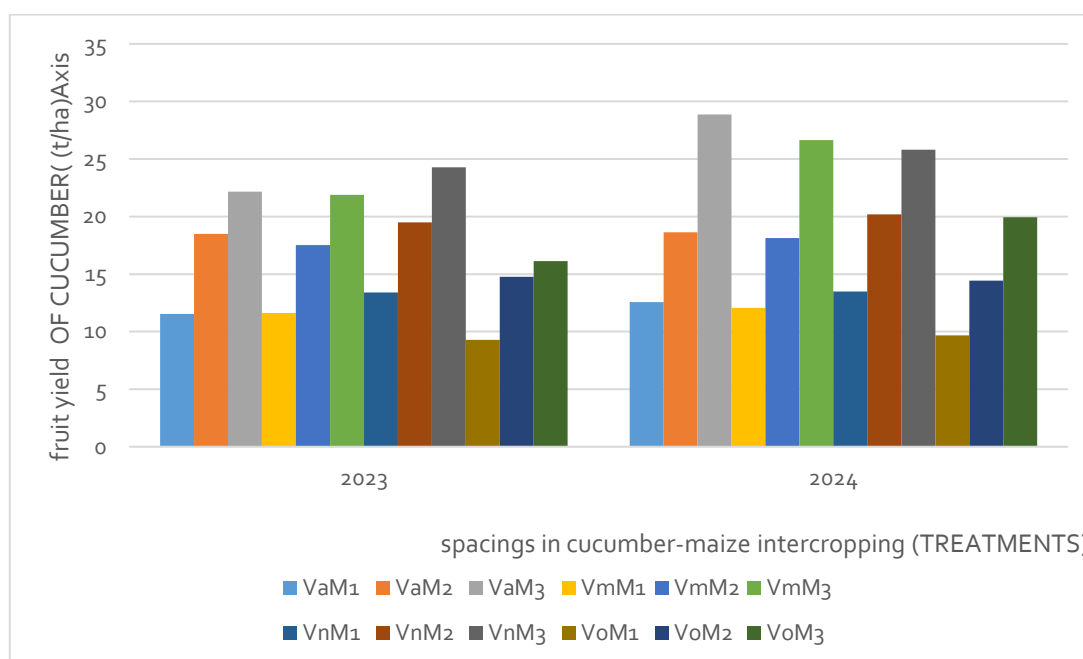


FIGURE 5: FRUIT YIELD (t/ha) OF CUCUMBER IN CUCUMBER-MAIZE SPACINGS

Discussion

This study revealed that the use of various spacing in the intercropping of cucumber-maize system had significant reduction in the population densities of *Aulacophora* spp (*A. foveicollis*, *A. hilaris*, *A. nigripennis*), *Acalymma vittatum*, *Diabrotica undecimpunctata*, *Epilachna elaterii* and had higher yield.

The larger the spacing used for the intercropping, the higher the population density on the cucumber and vice versa, so the smallest spacing (75cm x 25cm) used for the intercropping of cucumber-maize system had the lowest insect population density on cucumber. This is because the diversity of vegetation species per unit area is directly proportional to natural enemy abundance and richness which help to keep the population of insect pest regularly under check whereas herbivores are more likely to locate and dominate on plants that are growing in pure stands or less diversify per unit area (Saenz-Romo *et al.*, 2019), he further posited that the level of ground cover is positively correlated with predator insect diversity. This observation is contrary to the position of Adeoti *et al.* (2023), that gave an inverse relationship between the population density of the insect pest of cucumber with that of the spacing i.e the lowest population density of the insect pest was obtained from the spacing of 1m x 1m while the highest population density was obtained from the cucumber planted at 0.5m x 0.5m in a sole cropping system. Similarly, according to Bhanderi *et al.* (2024), the population density of leaf hopper, thrips, whitefly and mealy bug was inversely proportional to the spacing.

The cucumber-maize intercropping system with a smaller spacing had higher canopy cover for the natural enemy to guarantee less population of insect-pests of cucumber. This is possible because of the dissimilarity between maize and cucumber in relation to

architecture, tall crop such as traditional cereal varieties are able to disrupt the visual search of insects for the preferred host or the presence of lower storey crops can similarly affect visual search (Pitan and Filani, 2014).

In contrast, Valenzuela *et al.* (1994) reported that maize borders are more effective as trap crops to attract insect such as melon flies in the fields where there is no alternative weed hosts present around the field margin, thereby encouraging melon flies to congregate and makes it easier for beneficial insect to prey on them and for handpicking infested fruits and flowers.

Furthermore, higher fruit yield was obtained from cucumber- maize intercrop at a smaller spacing (75cm x 25cm) than that at larger spacing (75cm x 75cm and 75cm x 50cm). This position may be supported with the work of Falodun and Emede (2019) that reported higher yield of tomato from the spacing of 75cm x 40cm and 75cm x 50cm than that of 75cm x 60cm plant spacing. The reason that account for higher yield (t/ha) of cucumber in smaller spacings than that of larger spacings may be as a result of higher populations of cucumber plants per hectare when compared with that of larger spacings while larger spacings gave higher relatively higher yield per plant due to opportunity for better access to sunlight, nutrients and other resources.

Previous studies reported that increasing flower diversity enhances natural enemy abundance (Alcala Herrera *et al.*, 2022; Seree *et al.*, 2022) and limiting the distances of complementary crop to that of the other flowering plants is key for biological control and higher productivity (Albrecht *et al.*, 2020).

Conclusion and Recommendation

Spacing in cucumber-maize intercropping at 75cm x 25cm had lower infestation of *Acalymma vittatum*, *Diabrotica undecimpunctata*, *Aulacophora spp* and *Epilachna elaterii* on cucumber and had higher fruit yield than other spacings. The range of fruit yield (t/ha) between the Cucumber-maize intercropping at 75cm x 75cm and 75cm x 25cm was 9.29 t/ha-28.88 t/ha.

Based on the above conclusion, the following can be recommended:

- That cucumber farmers could intercrop cucumber with maize at the spacing of 75cm x 25cm for effective management of insect pests of cucumber.
- That intercropping of Cucumber-maize at the spacing of 75cm x 25cm could guarantee higher fruit yield of cucumber.
- The researchers recommend further research to compare each of this spacing used in cucumber-maize intercropping with that of cucumber monoculture at the same spacing in terms of insect population densities and fruit yield.
- Further research could concentrate data on the density, species richness of insect pests and natural enemy in cucumber-maize intercropping system.

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