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EFFECT OF SPATIAL CROP ARRANGEMENTS IN THE MANAGEMENT OF COMMON PESTS IN MAIZE-COWPEA INTERCROP

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ABSTRACT

This trial was conducted to evaluate the impact of special crop arrangement and time of introduction of component crop in a maize-cowpea intercrop system as a strategy to minimize reliance on chemical pesticides in pest management. The experiment was conducted from June to November at a field located on longitude N 9°17' and E 5°06', latitude and altitude in Mokwa Southern Guinea savanna of Niger State, Nigeria. A 2 × 3 + 2 factorial experiment was arranged in a Randomized Complete Block Design with three replications. The treatments include; sole maize, sole cowpea, and intercropping arrangements of one row of maize alternated with one row of cowpea (1:1) and two rows of maize alternated with two rows of cowpea (2:2). Additionally, the introduction of the component crop was varied, occurring either simultaneously with maize sowing, two weeks after maize sowing (2 WAS), or four weeks after maize sowing (4 WAS). The study monitored populations of common pests, including *Riptortus dentipes*, *Empoascadolichi*, Spiny brown bug, Giant coreid bug, *Aphis craccivora*, *blister bettle* and stem borer. The results indicated that pest populations were generally higher in sole crop plots than in intercropped plots, demonstrating that intercropping effectively reduces pest densities. The significantly lower pest abundance in intercrop treatments may explain the improved yield observed in the 1:1 cropping pattern when the component crop (cowpea) was introduced two weeks after maize was sown.

Keywords: Pest Population, Crop arrangement, Component Crop, *Empoascadolichi*, Maize-Cowpea Intercropping.

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INTRODUCTION

Agriculture plays a crucial role in ensuring food security and economic stability, particularly in regions like the Guinea Savanna of Nigeria, where smallholder farming is predominant. However, one of the major challenges faced by farmers in this region is the impact of insect pests on crop yield and quality. Pests such as aphids, pod-sucking bugs, and stem borers cause significant damage to crops, leading to yield losses and economic hardship. Conventional pest control methods, which rely heavily on agrochemicals, have been associated with environmental degradation, soil health deterioration, and increased production costs. Huang *et al*. (2014), pointed out that excessive application of these chemicals not only imposes financial strain on farmers but also poses serious health and environmental risks and stressed that their overuse has been linked to elevated concentrations of heavy metals in groundwater and crops, as well as soil acidification. As a result this, sustainable and eco-friendly pest management strategies are increasingly being explored, with intercropping emerging as a viable alternative.

Maize (*Zea mays*) is a staple cereal crop, while cowpea (*Vigna unguiculata*) is a valuable legume that enriches the soil with nitrogen and provides high-protein food for local communities. Intercropping is an agricultural technique used to grow two or more different crops in alternate rows on a given plot of farmland at the same time during their growing season or in a growing period (Blessing *et al*., 2022). They maintained that tall crop is often intercropped with a short crop in this farming system, such as intercropping a legume and cereal. According to Blessing *et al.* (2022), when maize and soya beans is intercropped, it increases soil fertility through nutrient acquisition, controls pests and disease, enhances maize lodging resistance, controls erosion, increases yield and land equivalent ratio (LER).Intercropping has been widely recognized for its ability to enhance productivity and creates a more diverse cropping environment that disrupts pest colonization, reduces insect reproduction rates, and enhances the presence of natural enemies. Hauggard-Nielson *et al*. (2001) supported this that farmers practiced different cropping systems to increase productivity and sustainability.

Toker *et al*, (2024) viewed intercropping as a cultural practice in pest management that reduces insect pests by increasing ecosystem diversity. It kills or repels pests, attract natural enemies, or have antibacterial effects that can reduce disease and pest damage and pesticide use. They stressed that intercropping, reduce the likelihood of pest infestation, ensure crop yield stability, protect against crop failure, improve soil fertility, increase soil conservation, and reduce pesticide use, minimizing agriculture's environmental impact. Intercropping also might lessen the prevalence of some pests and plant diseases, which in turn decreases the need for potentially dangerous pesticides. Additionally, under some conditions, helps to minimize crop water usage, enabling crops to be cultivated with little or no irrigation.

Agbor et al (2023) concluded that intercropping maize with dwarf beans and cowpeas increases maize output compared to solitary maize planting, demonstrating resource use efficiency. The potential of maize in controlling some insect pests when intercropped with certain crops has also been demonstrated in the studies conducted in Nigeria by Pitan and Fulani 2014, which showed reduction in the populations of *Empoascadolichi, Sericothrips occipitalis* and *Callosobruchus maculatus* in cowpea–maize intercrops. Similarly, Karel*et al*. (1982) reported a higher incidence of *Maruca* in monocrops of cowpea than when cowpea was intercropped with maize. A decrease in the population of pod-sucking bugs in cowpea–maize plots has also been reported (Pitan and Odebiyi, 2001). Oyewale *et al*. (2013), reported that mixed cropping of cereals with legumes results in better returns which was obtained by

alternating two rows of cowpea with one row of maize. Furthermore, Taiye and Olusegun (2012) reported that intercropping and maintenance of good component crop arrangement could effectively reduce virus incidence. Mailafiya and Degri, (2012) reported that crop diversification through intercropping, such as cereals with legumes, is effective in reducing insect pest damage. Rakotomalala, *et. al.*, (2023), conducted a systematic review and meta-analysis, using data from 18 countries published in 63 articles, to quantitatively assess the overall effect of intercropping on beneficial arthropods and pest populations founds that intercropping, compared to monocropping, significantly increased the overall abundance of beneficial arthropods by 36%, density by 94%, and species richness by 27%. Intercropping reduced 38% of the abundance and 41% of the density of arthropod pests, while their species richness was not affected.

Therefore the use of agronomic practices to control insect pest seems to be a better approach to cope with this menace of pest damage. This is cheap and does not constitute any danger to the environment and the user. The objective of this study therefore is to investigate the effectiveness of cropping geometry and time of introduction of the component crops on pest densities in maize-cowpea intercrop.

MATERIALS AND METHODS

Experimental Design and Treatment

The two-year experiment followed a split-plot design in which cowpea was introduced as a component crop in a maize-based intercrop system. The experiment was conducted from June to November at a field located on longitude N 9°17' and E 5°06', latitude and altitude in Mokwa Southern Guinea savanna of Niger State, Nigeria. A2 × 3 + 2 factorial experiment arranged in a Randomized Complete Block Design with three replications was established. The cropping ratio included 1:0 (sole maize) and (sole cowpea), 1:1 (one row of maize to one row of cowpea), 2:2 (two rows of maize to two rows of cowpea). The experimental field was divided into three blocks, each containing eight subplots, with three replications, totaling 24 subplots. Each subplot measured 4.0 m × 3.75 m (15 m²), with 1.0 m spacing between blocks and 0.5 m spacing between subplots. Prior sowing, the fields were plowed and leveled. Maize and cowpea seeds were manually sown using a hand hoe in June. Maize was sown at a spacing of 50 cm × 50 cm, with an inter-row spacing of 75 cm, while sole cowpea was sown at a spacing of 25 cm × 25 cm. The subplots represented different times of crop introduction into the system. Sowing was done manually, placing three seeds per hill, which were later thinned to two plants per hill at 2 weeks after sowing (WAS). No fertilizer was applied to cowpea, while maize received NPK fertilizer at a rate of 120 kg N/ha, 60 kg P^2O^5/ha and 60 kg K_2O/ha. No pesticides were applied to cowpea throughout the trial period. Maize was harvested at full maturity, and cowpea was harvested when pods were fully matured and dried. Seed weights were measured and adjusted to a constant moisture content of 15% for maize and 13% for cowpea. The study focused on the population dynamics of common pests observed in the study area, including: *Riptortus dentipes* (Spiny Brown Bug), *Empoascadolichi* (Leafhopper), *Aphis craccivora* (Cowpea Aphid), Giant Coreid Bug, *blister bettle* and stem borer.

Statistical Analysis

Data were analyzed using Analysis of Variance (ANOVA) with DSAASTAT, and means were separated using Least Significant Difference (LSD) at a 5% probability level. Insect richness and abundance data were analyzed using Paleontological Statistical Tools (PAST).

RESULTS

Result of Analysis of variance

The results of combined mean square analysis of variance revealed existence of significant differences among pests' population studied against crop geometry as shown in table 1, and time of introduction of component crop as in table 2.

Table 1: Combined mean square of analysis of variance of crop geometry on insect pest population in Maize-Cowpea intercrop

Crop geometry	*Riptortus dentipes*	*Empoasca*	*Spiny brown bug*	*Giant coreid bug*	*Blister bettle*	*Aphids*	Stem tunnel
1:1	5.33	12.78	10.33	2.00	6.33	1.78	1.51
2:2	5.78	9.56	12.33	2.22	9.11	2.11	1.78
Sole	14.33	14.33	28.33	6.33	19.67	4.00	6.76
LSD	5.26	3.44	2.80	4.33	5.70	1.37	3.98
	*	*	*	*	*	*	*

Table 2: Combined mean square of analysis of variance of Time of introduction of component crop on insect pest population in Maize-Cowpea intercrop

Time of introduction	*Riptortus dentipes*	*Empoasca dolichi*	*Spiny brown bug*	*Giant coreid bug*	*Blister bettle*	*Aphids*	Stem tunnel
Same Time	8.27	12.50	15.00	2.83	7.67	2.50	1.50
2WAS	6.67	14.57	9.83	2.50	11.83	1.83	1.94
4WAS	1.83	6.33	9.20	1.00	3.67	1.50	1.50
LSD	1.54	3.02	2.20	0.31	3.04	0.56	0.62
	*	*	*	*	*	*	*

Impact of Crop arrangement on Pest Population Density

The result on figure 1 showed that the population of pests under study increased when cowpea was sown sole, this indicates that cowpea is the most preferred host for these pests. *Spiny brown bug* recorded highest population per plot on the sole crop plot and plot with 2:2 sowing pattern. *Riptortus dentipes* and *Empoascadolichi* rank the same in population under sole cowpea cropping pattern and significantly differed in cropping ratio 1:1 and 2;2 respectively, indicating the influence of the component crop (Maize) in the intercrop. *Blister*

bettle, *Aphids* and stem tunnel indicating activity of stem borer were consistently low across the cropping geometry. Figures 2, revealed that population of the pests were significantly higher when the two crops were sown at the same time. However, introduction of cowpea 4 weeks after sowing maize reduced the population of the pests generally.

Figure 3 revealed that higher yield of cowpea was obtained when one row of maize was alternated with one row of cowpea. The low yield recorded in sole cowpea plot could be attributed to abundant pest infestation.

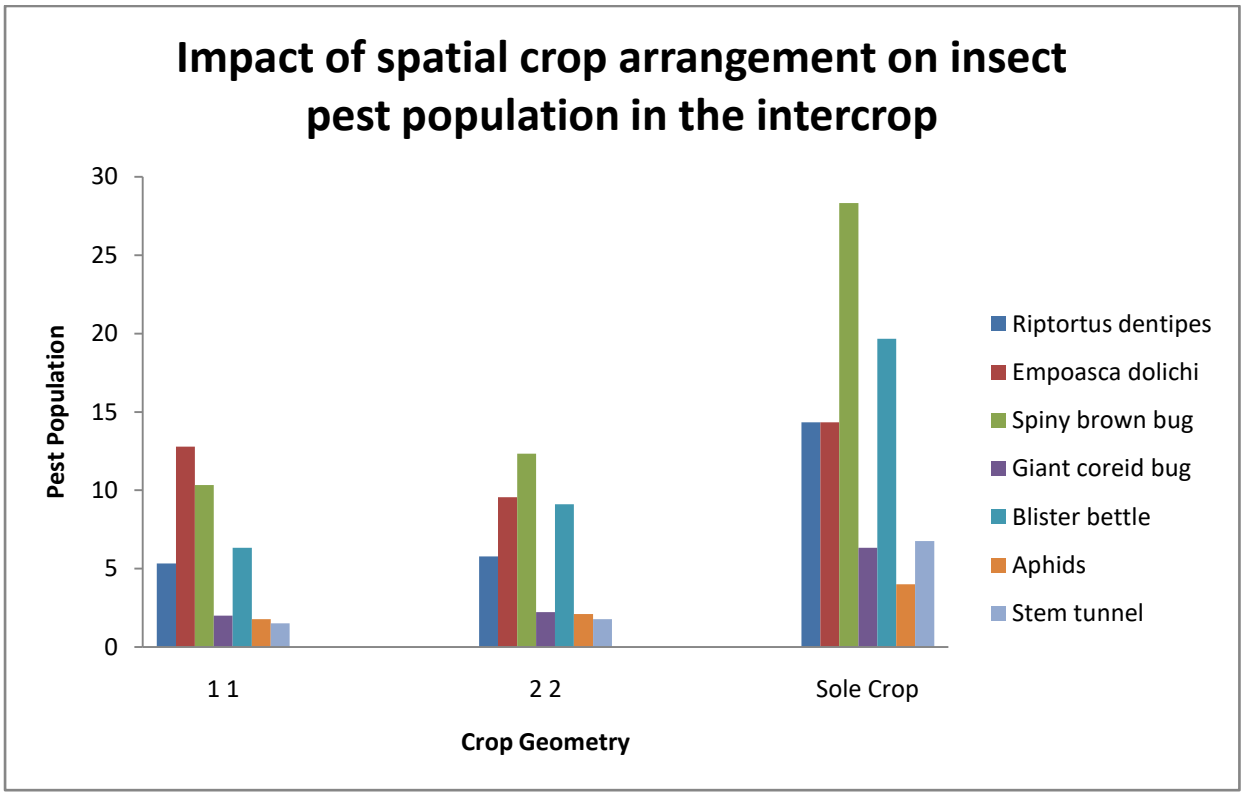


Fig 1: Impact of crop arrangement on the population density of pest in the intercrop.

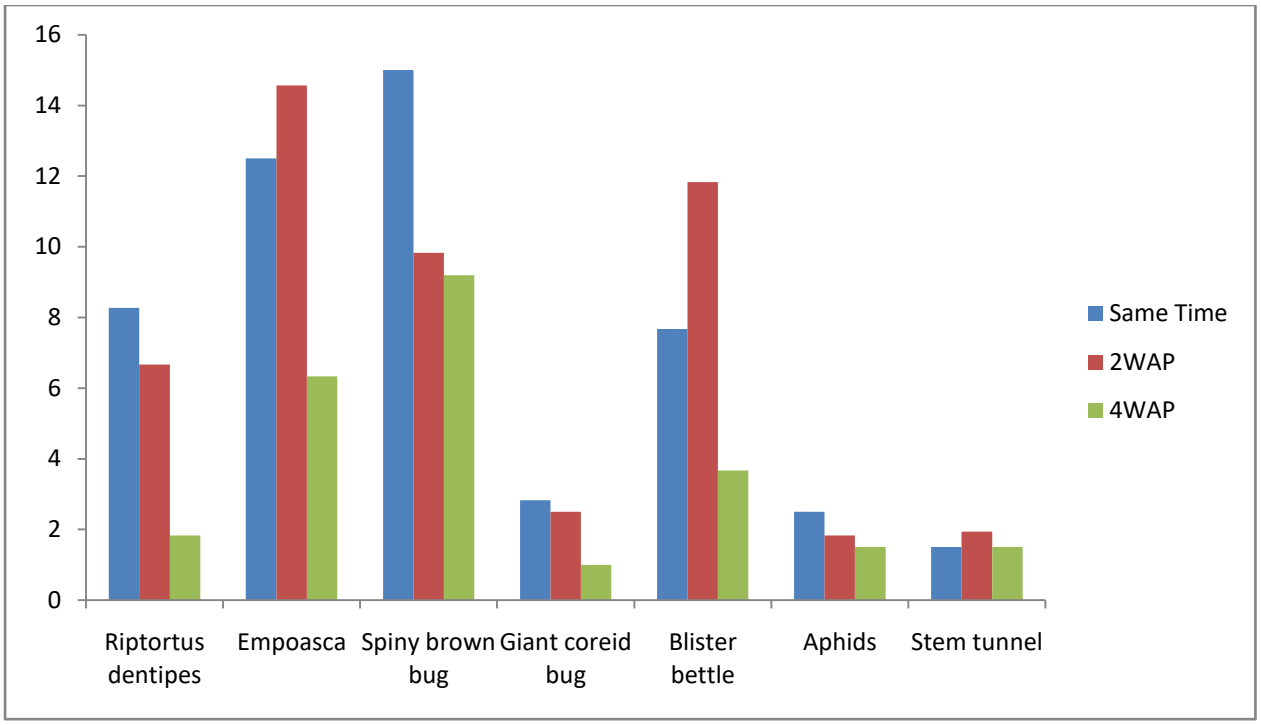


Fig 2: The effect of time of introduction of component crop on population density of pests in the intercrop

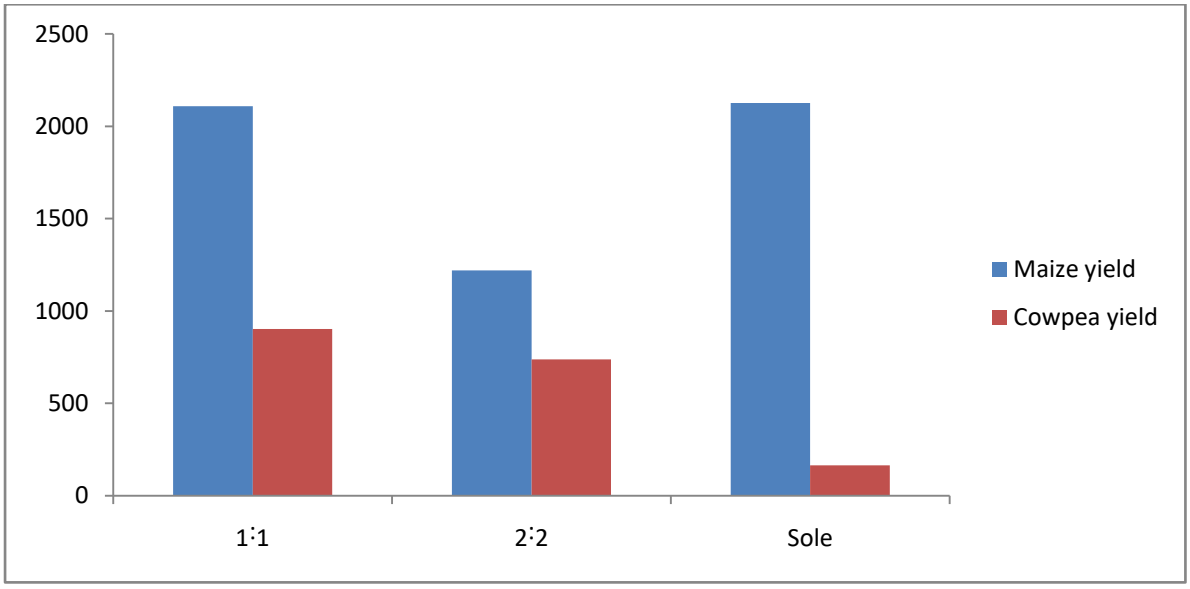


Fig 3: Effect of crop arrangement on yield of Maize and Cowpea in Maize-Cowpea intercrop

DISCUSSION

The consequences of pesticide and insecticide use in pest control have heightened interest in the effectiveness, efficiency, and sustainability of non-chemical pest management strategies. Research has demonstrated that cultural practices such as intercropping can significantly reduce field pest infestations. Bach (1980) observed that intercropped fields tend to support

higher populations of predators and parasitoids than monocropped fields, leading to lower insect pest populations due to increased biological control.

In this study, the incidence of Spiny Brown Bug was found to be higher in sole-cropped fields compared to intercropped plots. This may be attributed to a lower population of natural enemies in the sole crop. This result is supported by the findings of Soundararajan (2012), who reported lower *Empoascakerri* populations in sorghum-cowpea intercropping systems. Similarly, Ofuya (1991) found that intercropping cowpea with tomato significantly suppressed *Empoascadolichi* infestations. Additionally, research by Ogenga-Latigo *et al*., (1993) revealed that *Aphis fabae* infestations in beans were significantly reduced when beans were intercropped with older, taller maize plants.

The abundance of Spiny brown bug populations when maize and cowpea were sown simultaneously at ratios of 1:1, 2:2; and in sole cropping systems revealed pest host specificity. However, pest populations declined when cowpea was introduced four weeks after maize was sown, suggesting that Spiny Brown Bug prefers maize and cowpea of similar growth stages. This finding aligns with the report of Gathi and Khaemba (2008), who observed greater pod-sucking bug damage in cowpea-maize intercrop systems when both crops were of the same age.

Furthermore, intercropping maize and cowpea in a 1:1 row arrangement resulted in significantly higher populations of *Aphis craccivora* compared to the 2:2 row pattern and sole cropping systems. However, Emeasor and Ezuch (1997) reported that intercropping maize with cowpea significantly reduced infestations of *Aphis craccivora* and *Blister beetle*. Ampong-Nyarko *et al*., (1994) attributed such reductions in insect pest populations in intercropped systems to increased plant diversity, which creates an unsuitable habitat for certain pest species through colonization deterrence.

A general decline in insect pest populations was observed as the introduction of the companion crop was delayed from simultaneous sowing to two and four weeks after maize was sown. This is consistent with findings by Pitan (2013), who reported lower populations of major cowpea insect pests when maize was sown four and six weeks prior to cowpea. Additionally, higher incidence of Stem borer in sole-cropped maize compared to intercropped systems suggests that intercropping acts as a deterrent to stem borer spread, likely due to disrupted pest movement and host location.

The higher yields obtained from intercropping systems in this study can be attributed to the lower insect pest populations. Nampala *et al*. (2013) reported increased maize and cowpea yields in intercropped systems due to reduced pest pressure. Furthermore, the timely introduction of legumes in intercropping systems minimizes competition with maize for light, water, and nutrients, contributing to improved yields.

CONCLUSION AND RECOMMENDATION

It was evident that the insect pest population was higher in sole cowpea crop than in intercrop. The higher yield obtained from the cropping pattern 1:1 at 2 weeks after planting, suggests that the intercrop ratio is at the optimum proportion. Yield increase may have occurred due to the low insect pest population. It is however assumed that the component crop utilizes deferent portion of the environmental resources occasioned by the morphological differences between maize and cowpea.

From this study, cropping pattern of one row of maize to one row of cowpea (1:1) and introduction of cowpea two weeks after sowing maize kept the pest population low and increase yield and it is therefore recommended to farmers to boost performance and yield of cowpea without the use of pesticides

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