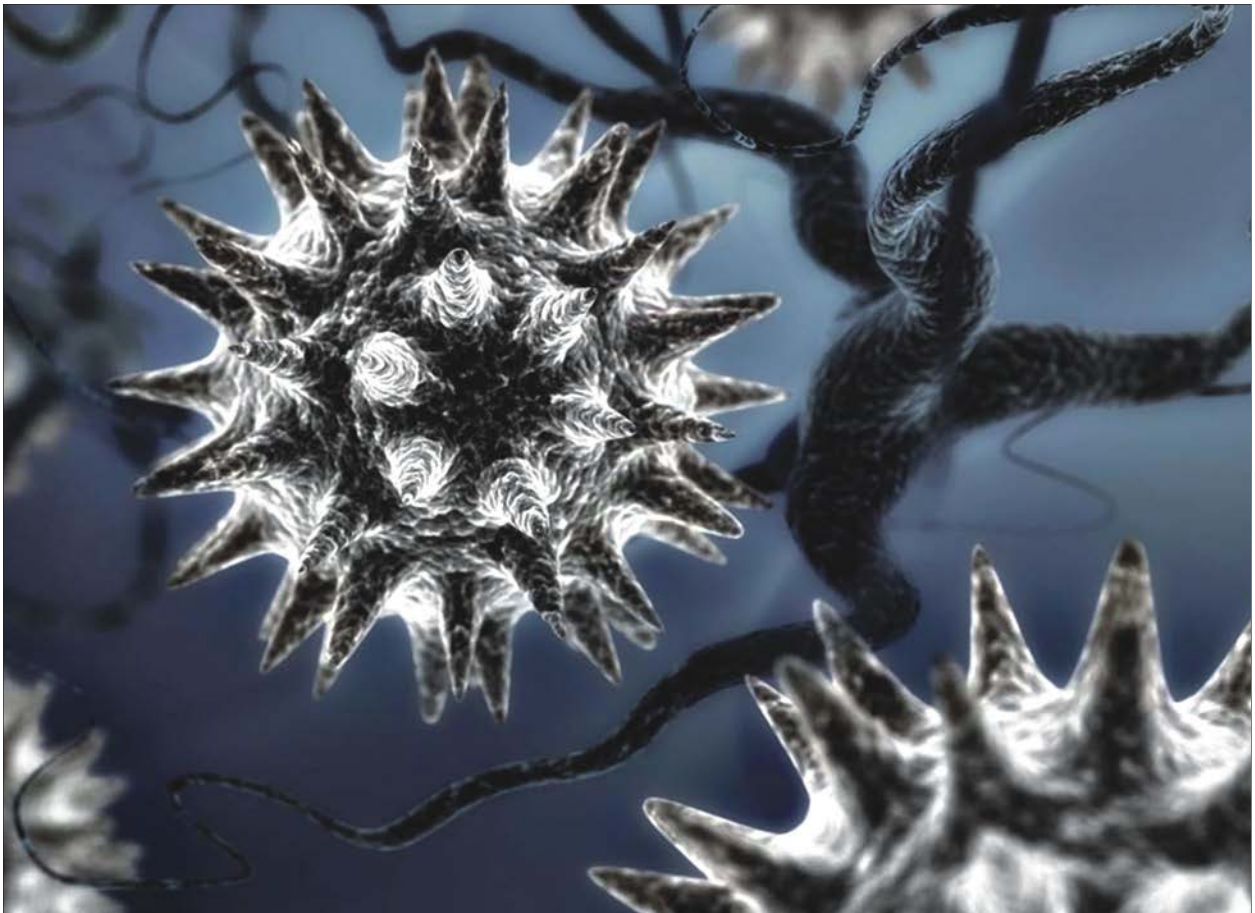

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Effect of Spatial Arrangement on the Incidence of Virus Diseases Associated with Cowpea Intercropped with Maize

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ABSTRACT

Virus diseases have constituted great constraint to cowpea production leading to reduced yields, it is important to evolve control strategies that is ecologically friendly and sustainable. A field experiment was carried out at the Teaching and Research Farm of the University of Ilorin, Kwara State-Nigeria (8.29°N and 4.41°E), during the 2010 cropping season to evaluate the effect of spatial arrangement on the incidence of virus diseases associated with cowpea intercropped with maize. This is with the view to determining if this method which is cheap and easy to apply could be effective in virus control. The experiment was laid out as a randomized complete block design. The treatments were three arrangement pattern of cowpea-maize-cowpea-maize, cowpea-cowpea-maize-maize and sole cowpea (control). Each of the treatments was replicated three times and these were randomly assigned to the plots. The results of the experiment showed that although incidence of virus diseases existed in all the treatments, there were differences between them. Significantly lowest virus disease incidence was obtained in plots with cowpea-maize-cowpea-maize arrangement. This intercropping arrangement also led to the highest yield parameters compared to the other two treatments. Plots with sole cowpea had the highest incidence of viruses and consequently lowest yield attributes. The results indicated that intercropping and component plant arrangement could be effective in reducing virus incidence.

Key words: Intercropping, cultural control, virus transmission, crop environment, bio-diversity, agricultural sustainability

INTRODUCTION

Cowpea (*Vigna unguiculata* L. Walp.) originated in Africa and it became an integral part of traditional cropping systems throughout Africa particularly in the semi arid region of West Africa savanna (Olufajo and Singh, 2002). Legumes are important sources of protein for man and animals globally (Singh, 2011). In Nigeria cowpea is grown more in the drier region of northern Nigeria but its cultivation has also gained grounds in east, west and southern Nigeria (IITA, 2004). About 7.56 million tons of seeds are produced annually on about 12.75 million hectares of land (IITA, 2007). Cowpea is shade-tolerant and therefore compatible as an intercrop (Singh and Sharma, 1996).

One of the most important objectives in farming systems is to minimize the risk probability as well as maximize production level (Dahmardeh and Dahmardeh, 2010). While farmers are developing a strong interest in cowpea production they still face several adverse factors, among which is the prevalence of diseases and insect pests (Edema and Adipala, 1996; Omongo *et al.*, 1998; Singh *et al.*, 2003). Most cowpea crops are rain-fed and although, it is drought tolerant, cowpea farmers in the dry savanna areas of sub-Sahara Africa obtain low yield estimated at about 350 kg ha^{-1} because of problems associated with pathogens such as viruses (IITA, 2007).

Viral diseases have long been associated with yield losses ranging from 10-100% in field grown cowpea crops (Taiwo, 2003). The plants are often infected by more than one virus disease and this can cause serious economic losses (Kang *et al.*, 2005). The disease symptoms caused by viruses vary but the most common symptoms in cowpea include: systemic chlorosis, leaf distortion, leaf mottling and stunting of plants (Ng and Perry, 2004). Saidi and Safaeizadeh (2011) reported the natural infection of cucumber mosaic virus on *Pelargonium* in Iran, also in Southern India, sunflower leaf curl disease caused by a begomovirus and transmitted by *Bemisia tabaci* was observed to an extent of 40% on some sunflower hybrids grown in experimental plots in (Govindappa *et al.*, 2011). This implies that viruses are threats to optimum agricultural production and effective control measures are warranted.

Intercropping can be defined as the growing of two or more crops on the same piece of land within the same year to promote their interaction and maximize chances of productivity by avoiding dependence on only one crop (Sullivan, 2003). It is a common practice among traditional farmers of the Nigerian savannah (Elemo *et al.*, 1990). Some improved and profitable intercropping practices have been developed for crops such as cowpea and maize (Chang and Shibles, 1985; Ofori and Stern, 1986) and found useful in the control of disease infestation (Pitan and Odebiyi, 2001). Intercropping has advantages in terms of intensive land uses and the reduction of production risks for the small-scale farmer more than in sole cropping (Mousa *et al.*, 2007).

Spatial arrangements and plant densities of the component species are generally manipulated to enhance complementarities and reduce interspecies competition in order to maximize agronomic and physiological advantages (Silwana and Lucas, 2002). The spatial arrangement of the legume crop is one important management factor that could determine the sustainability of an intercropping system. Crop arrangements was found to influence Nitrogen response in growth development of late season maize/soybean intercropping (Undie *et al.*, 2012). In soybean for example, highest yield were obtained with an appropriate planting density in combination with suitable planting arrangements (Rahman and Hossain, 2011).

Attempts have been made in the past to develop control practices which are cheap, effective and that have low persistence in the environment. The use of plant extracts at different concentrations was found effective in controlling the growth of bacterial colonies in Irish potatoes (Wagura *et al.*, 2011). Derbalah *et al.* (2011) found that *Bauhinia purpurea* was the most effective plant extract against tomato early blight disease. Cultural practices such as varietal differences and plant population have also been found effective in the control of virus diseases (Aliyu and Balogun, 2011).

Relatively few studies have addressed the use of spatial arrangement as an intercropping system in ameliorating the pathogenic effect of viruses on cowpea. The objective of this study therefore, was to investigate the efficacy of the component plant arrangement of cowpea/maize intercrop on the incidence of virus diseases.

MATERIALS AND METHODS

The experiment was carried out at the University of Ilorin Teaching and Research Farm, between August and October, 2010. The farm is approximately 307 m above sea level and is located within the Southern Guinea savannah ecological zone (8°29' N, 4°41' E) of Nigeria. The annual rainfall is between 1250-1500 mm with a mean temperature range of between 20 and 35°C. The soil type is a well drained sandy-loam.

Experimental design and field layout: A factorial fitted into a randomised complete block experimental design was established. The treatments were as follows:

- Treatment 1: Cowpea-maize-cowpea-maize (1-1)
- Treatment 2: Cowpea-cowpea-maize-maize (2-2)
- Treatment 3: Sole cowpea

The treatments were replicated three times and randomly assigned. A plot consisted of 4 ridges and each ridge was 5 m long. The seed varieties used for cowpea and maize was Ife-brown and DMR (Oba Super) respectively and spacing was at 30 cm intra-row. Plantings were done at intervals of two weeks for the intercropping treatments. N-P-K and Urea fertilizers were applied appropriately (twice), at the rate of 100 kg ha^{-1}. Insect pests were controlled by the use of Cypermethrin and weeding was manual.

Data collection: Data was collected only on the cowpea plants for the following parameters: Number of plants per plot, number of plants with viral disease per plot, height of the plant (cm), number of leaves per plant, number of pods per plant using 5 plants from each sub-plot, pod weight and grain weight. Percentage disease incidence was calculated from collected primary data as follows:

$$\text{Disease incidence (\%)} = \frac{\text{No. of infected plants}}{\text{Total No. of plants per plot}} \times 100$$

All data collected were subjected to analysis of variance and where significant differences existed at 5% level of probability, the LSD was used to compare the means.

RESULTS

Percentage disease incidence: Table 1a shows the mean squares from the analysis of variance and Table 1b shows the means of the effect of the treatments on percentage virus disease incidence on cowpea plants. The result shows that up to the 4th week after planting, apparently there was

Table 1a: The mean square effect of spatial arrangement on percentage virus disease incidence in cowpea at different times after planting of cowpea/maize intercrop

SOV	df	Incidence week 5 (%)	Incidence week 6 (%)	Incidence week 7 (%)	Incidence week 8 (%)
Treatment	2	43.30**	70.20**	30.03**	324.17**
Error	49	0.47	0.54	1.32	1.16

**Significant at p< 0.01

Table 1b: The mean effect of spatial arrangement on percentage virus disease incidence in cowpea at different times after planting of cowpea/maize intercrop

Treatment	Incidence week 5 (%)	Incidence week 6 (%)	Incidence week 7 (%)	Incidence week 8 (%)
1	0.2^a	0.5^a	4.3^a	8.8^a
2	2.5^b	3.2^b	6.6^b	11.4^b
3	3.1^c	4.3^c	9.6^c	17.1^c
SE	0.16	0.17	0.27	0.25
LSD	0.46	0.49	0.77	0.72

Values with different letters show significant effect

Table 2a: The mean square effect of spatial arrangement on plant height at different times after planting of cowpea/maize intercrop

SOV	df	4th week	5th week	6th week	7th week	8th week
Trt	2	2.04 ns	23.90*	31.07*	94.14**	84.64**
Error	49	3.23	6.88	12.90	9.27	8.01

**Significant at $p<0.01$, *Significant at $p<0.05$, ns: Not significant

Table 2b: The mean effect of spatial arrangement on plant height at different times after planting of cowpea/maize intercrop

Treatment	4th week	5th week	6th week	7th week	8th week
1	20.7	23.3^{b}	29.9	36.5^{b}	43.6^{b}
2	20.3	25.6^{a}	32.4	40.1^{a}	47.5^{a}
3	20.0	24.3^{ab}	30.7	35.9^{b}	43.9^{b}
SE	0.42	0.62	0.85	0.72	0.67
LSD	1.20	1.76	2.40	2.04	1.90

Values with different letters show significant difference

no incidence of virus diseases. Symptoms became manifest however, by the 5th week after planting and increased on many more plants through to the 8th week after planting when the reading was terminated. In each of the weeks, significant differences existed between the treatments with regards to the incidence of virus diseases. Specifically, at the 5th week, treatment 1 which had the intercrop pattern of cowpea-maize-cowpea-maize (1:1) on the row, had the lowest disease incidence (0.2%), while treatment 3 (sole cowpea), had the highest value of 3.2%. Treatment 2, cowpea-cowpea-maize-maize (2:2), had a slightly lower disease incidence of 2.5%. This trend was recorded to the 8th week of observation, with the intercrop pattern of cowpea-maize-cowpea-maize (1:1) having the lowest incidence of virus diseases, followed by the intercrop pattern of cowpea-cowpea-maize-maize (2:2) and the sole cropped cowpea consistently having the significantly highest percentages of virus incidence.

Growth attributes

Plant height: The analysis of variance shows that up to the 4th week after planting heights of plants under the different treatments were not significantly different from each other (Table 2a, b). However, between the 5th and 8th weeks heights varied significantly. Treatment 2 plants produced the tallest plants in the 7th and 8th weeks (40.1 and 47.5 cm, respectively), while the other treatments did not differ significantly between each other.

Number of leaves: Table 3a and b show the result of analysis of variance of the effect of the treatments on Mean number of leaves per cowpea plant. The result shows that at 4th week after planting, Treatment 1 (cowpea-maize-cowpea-maize) had the highest mean number of trifoliate leaves per plant (5.6) which was significantly different from Treatment 3 (sole cowpea) which produced the lowest number of leaves per plant (5.0). Between the 5th and 8th weeks of observation, there were significant differences between the treatments in regards to the number of leaves per plant. At the 8th week of observation, cowpea plants under Treatment 2 produced the significantly highest number of leaves per plant (34.1), while cowpea plants in Treatment 1 produced the lowest the lowest number of leaves (31.4), although this value was not significantly different from the values obtained in Treatment 3 (33.8).

Yield attributes: Table 4a and b show the result of analysis of variance of the effect of treatments on some of the cowpea yield parameters. The mean number of pods per plant at 8 weeks after

Table 3a: Mean square effect of spatial arrangement on mean number of leaves per plant at different times after planting of cowpea/maize intercrop

SOV	df	4th week	5th week	6th week	7th week	8th week
Treatment	2	1.62*	20.82**	76.16**	53.90**	40.09**
Error	49	0.39	3.48	5.84	7.04	5.81

**Significant at $p<0.01$, *Significant at $p<0.05$

Table 3b: Mean effect of spatial arrangement on mean number of leaves per plant at different times after planting of cowpea/maize intercrop

Treatment	4th week	5th week	6th week	7th week	8th week
1	5.60[a]	8.10[b]	12.80[b]	21.10[b]	31.40[a]
2	5.30[ab]	10.10[a]	16.80[a]	24.20[a]	34.10[b]
3	5.00[b]	9.70[a]	15.30[ab]	24.00[a]	33.80[a]
SE	0.15	0.44	0.57	0.63	0.57
LSD	0.40	1.30	1.60	1.80	1.60

Values with different letters show significant effect

Table 4a: Mean squares effect of spatial arrangement on some yield attributes of cowpea at different times after planting of cowpea/maize intercrop

SOV	df	No. of Pods at 8th weeks after planting	Mean No. of seeds pod^{-1}	Pod wt.	Seed wt.
Treatment	2	7.10**	251.10**	213.40**	99.50**
Error	49	2.41	0.83	2.18	0.96

**Significant at $p<0.01$

Table 4b: Means effect of spatial arrangement on some yield attributes of cowpea at different times after planting of cowpea/maize intercrop

Treatment	No. of pods at 8th weeks	Pod wt. plant^{-1}	No of seeds pod^{-1}	Seed wt. plant^{-1} (g)
1	16.70[a]	12.80[a]	14.70[a]	8.70[a]
2	15.90[b]	9.30[b]	11.50[b]	5.90[b]
3	15.50[b]	5.30[c]	7.80[c]	4.00[c]
SE	0.37	0.23	0.35	0.23
LSD	1.04	0.61	0.99	0.66

Values with different letters show significant effect

planting shows that Treatment 1 had the significantly highest number of pods per plant (16.7), while Treatment 3 had the significantly lowest number of pods per plant (15.5). The analysis of the results for the pod weights per plant shows that significant differences existed for all the treatments. Treatment 1 produced the significantly highest pod weights (12.8 g), while Treatment 3 (sole cowpea) produced the significantly lowest pod weights per plant (5.3). The analysis of the other yield parameters also indicated that Treatment 1 produced the significantly highest number of seeds per plant (14.7) and highest seed weights per plant (8.7 g). In converse, Treatment 3 had the significantly lowest number of seeds per plant (7.8) and seed weight per plant (4.0), respectively.

DISCUSSION

Farmers are continually developing a stronger interest in cowpea production given its potential as economic crop and its ability to fix nitrogen in the soil. However, various factors such as pathogens and very importantly viruses hinder the realization of these noble objectives. Most plant viruses depend on vectors for their survival and spread, a most effective way of controlling viruses could therefore, be by the use of an efficient cropping system that would interfere with vector landing and feeding (Raccah and Fereres, 2009). Intercropping in the recent past has been found to reduce the final incidence of cassava mosaic disease in cassava cultivars intercropped with maize (Fondong *et al.*, 2002).

The present study has also shown that intercropping cowpea with maize caused a reduction in the incidence of virus diseases leading to higher yields per plant compared to sole cropping. The reduction in the incidence of virus diseases in the intercropped plots and the resultant high yields recorded compared to the sole cropped cowpea could be as a result of the maize plants acting as a barrier crop for insects that serve as vectors of plant pathogenic viruses. Altieri (1994) had reported that intercropping of compatible plants encourages biodiversity by providing a habitat for a variety of insects and soil organisms that would not be present in the single crop environment. This biodiversity can directly help to limit outbreaks of crop pest by increasing the diversity or abundance of natural enemies such as spiders and parasitic wasps that can feed on insect pest transmitting viral diseases.

This study also showed that cowpea plants intercropped in the pattern of cowpea-maize-cowpea-maize (1:1) had preferable yields and were less susceptible to viruses compared with the intercrop pattern of cowpea-cowpea-maize-maize (2:2). This finding is in contrast to that of Mayaka (1995), who reported that cowpea yield was 57% higher in cowpea-cowpea-maize-maize (2:2) intercrop compared with cowpea-maize-cowpea-maize (1:1). The contrast may be as a result of differences in the cowpea varieties used.

RECOMMENDATION

This research recommends that intercropping could be used to reduce the incidence of virus diseases of cowpea and that an intercropping pattern of cowpea-maize-cowpea-maize (1:1) which indeed produced significantly higher yields in this study may be preferable in this part of the country.

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