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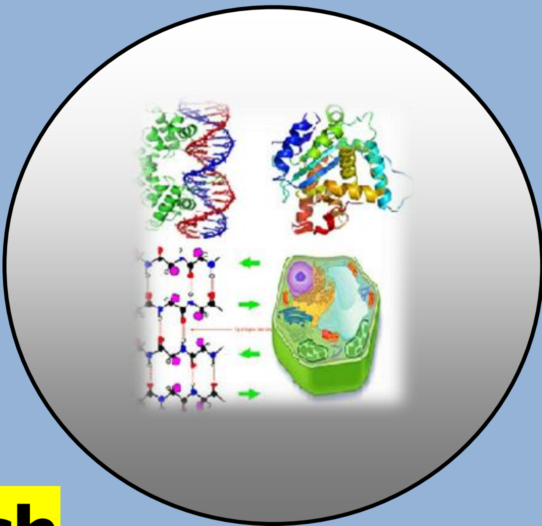

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RESEARCH PAPER

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Intercrop and Crop Combination Effect on Virus Disease Incidence, Growth and Yield of *Capsicum Spp* in a Pepper-Maize Intercrop

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ABSTRACT

A field experiment was conducted at the experimental field of National Horticultural Research Institute (NIHORT) Ibadan, during the 2013 and 2014 cropping season. The experiment was laid out in a Randomized Complete Block Design (RCBD) with five treatments replicated three times. The pepper seeds were nursed in the screen house for 30 days while the maize seeds were sown directly at two weeks before transplanting the pepper seedlings. Five crop arrangements were used as treatments in the experiment; maize-pepper-maize-pepper (MPMP), pepper-maize-pepper-maize (PMPM), maize-pepper-pepper-maize (MPPM), pepper-maize-maize-pepper (PMMP) and sole pepper which acted as a control. Sole pepper had the highest disease incidence (70.83%), MPPM had 22.92% while PMPM had the lowest incidence (14.58%). The disease severity was lowest in PMPM (2.0) and highest in sole pepper (3.83). Treatment 3 which is the intercropping pattern MPPM gave good responses by producing both the highest number of fruits (3.92) and highest fruit weight (28.34g) per plant compared to the sole pepper which gave an average of 2 fruits and an average weight of 13.62g per plant. It can therefore be concluded that maize-pepper intercropping could be used to reduce the incidence of virus disease of pepper and at the same time give good yields.
Key words: Crop-Arrangement, Incidence, Intercropping, Maize, Pepper and Severity.

INTRODUCTION

Pepper is one of the most important crops in Africa. It is also cultivated worldwide under diverse environment and climatic conditions, covering an area of nearly one million hectares (Arogundade, 2012). Pepper is an essential ingredient in many dishes worldwide because it gives color, flavor and aroma in foods in addition to being a good source of vitamins (particularly vitamin A) and minerals (Olaniyan and Fawusi, 1992).

Pepper used to be a cash crop for export and for local domestic use in the form of soap making, preservatives, flavor and savory condiment for local and international dishes (Olarewaju and Showemimo, 2002). Nigeria is the largest producer of green pepper in Africa and the total area devoted to the crop annually is about 60,000ha, representing about 40% of the average daily vegetable consumption in the country, (FAO, 2014).

Capsicum spp generally are suitable hosts for a large number of plant pathogens. These pathogens cause significant damages which invariably limit their productivity (Salami, 1999).

Most plant viruses depends 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 (Racah and Fereres, 2009).

Spatial arrangement and plant densities of the component species are generally manipulated to enhance complement and reduce inter species competition in order to maximize agronomic and physiological advantage (Silwana and Lucas, 2002).

Also, a survey carried out in some states in the northern part of Nigeria, showed that viral diseases incidence was drastically reduce in pepper/ sorghum and pepper/ maize crop mixture compared with sole pepper which had highly significant disease incident (Alagbejo and Ujah, 1987). This experiment is therefore aimed at determining the effect of intercrop and crop arrangement on the incidence and severity of viral diseases of pepper as well as growth and yield of pepper in a pepper-maize intercrop.

MATERIAL AND METHODS

This experiment was carried out at the experimental plot of the National Horticultural Research Institute (NIHORT), Idi- Ishin, Jericho, Ibadan during the raining season of 2013 and 2014. Maize and pepper was intercropped using different arrangements.

Source of Maize and Pepper Seeds

The pepper seeds used for this experiment were extracted from fruits of long cayenne pepper and obtained from a pepper farmer. The seeds were extracted from the fruit and air dried. The maize seeds were obtained from a maize farmer.

Land preparation and seeding

The beds were made manually after ploughing and harrowing using the hoe. The land was then partitioned into fifteen beds each measuring 4.2m x 1.8m and 1m maintained between and within each bed.

The pepper seeds were nursed in trays for 30 days in the screen house. This is to carefully control conditions for growth and development to ensure survival of more seeds and to raise healthy seedlings. The nursery trays were watered thrice a week to allow seeds get access to the required quantity of water necessary for proper development.

Planting and Transplanting

The maize seeds were sown directly two weeks before transplanting the pepper seedlings. Regardless of the arrangement, a total of 48 seeds were sown in each bed i.e 3 seeds per planting hole which were later reduced to 2 plants per hole.

The maize plants were planted at a spacing of 60cm x 60cm giving a total population of 480 plants. The pepper transplants were set out into the field two weeks after planting of maize at a spacing of 60cm x 60cm giving a plant population of 480. NPK (15:15:15) was applied by ring placement at the rate of 2g/stand for pepper plants two weeks after transplanting. Manual weeding was done as at when necessary.

Treatment Design

The experiment was laid out in a Randomized complete block design with three replications. In all, fifteen beds were used and the treatments were randomized in all plots. The treatments were arranged as;

Treatment 1: MPMP-Maize-Pepper-Maize-Pepper
Treatment 2: PMPM-Pepper-Maize-Pepper,-Maize
Treatment 3: MPPM-Maize-Pepper-Pepper-Maize
Treatment 4: PMMP-Pepper-Maize-Maize-Pepper
Treatment 5: PPPP-Pepper-Pepper-Pepper-Pepper

Data Collection and Analysis

Data were collected fortnightly; the plant height, number of leaves, days to flowering, days to fruiting, number of fruits and weight of fruits were taken. Furthermore, percentage disease incidence and average severity were also recorded.

All data were subjected to analysis of variance (ANOVA) using the statistical analysis software (SAS) package and the means separated using the new Duncan Multiple Range Test (DMRT) at 5% level of significance. The severity score was computed using the scale as described (Arogundade, 2012);

1 = No visible symptoms
2 = Mild mosaic/mottling/yellowing/mild necrosis on few leaves /branches of a plant (symptoms on less than 25% of the plant); symptom recovery
3 = moderate mosaic/puckering/mottling/yellowing/necrosis on many leaves/plants and vein clearing (symptoms cover 50% of the plant)
4 = Severe mosaic/puckering/mottling/yellowing/necrosis (symptoms on entire plant)
5 = Severe mosaic/puckering/mottling/yellowing/necrosis and severe stunting (entire plant)
6 = Severe mosaic/puckering/mottling/yellowing/necrosis and severe stunting (entire plant), deformation and death of the infected plants. Mean of these scores was expressed to determine the average severity of virus diseases in the field

Percentage virus disease incidence was calculated in each farm surveyed using the formula.

$$\textit{Percentage incidence} = \frac{\textbf{Number of infected (symptomatic) plants x 100}}{\textbf{30}}$$

RESULTS

Table 1 shows that PMMP had the tallest plants (25cm) at 8 weeks after transplant closely followed by MPPM (24.73cm) and MPMP had the shortest plants (18.31), however there was no significant differences between all treatments. Table 2 shows that PPPP had plants with the highest number of leaves with an average of 31 leaves per plant Although, the analyses of variance show that up to the 8^{th} WAT, both the height of plants and number of leaves under the different treatments were not significantly different from each other.

Table 3 shows the result of the analysis of variance of the effect of treatments on viral disease incidence of pepper. The result shows that at 2WAT, apparently there was no incidence of virus diseases. Symptoms of viral diseases became manifest however at 4th WAT and increased on many more plants through to 8th WAT. Specifically at 4WAT, treatment 3 which had the intercrop pattern of MPPM had the lowest disease incidence (2.42%), while treatment 5 sole pepper had the highest disease incidence (10.42%). The sole cropped pepper consistently had the significantly highest percentage incidence of virus diseases. The trend continued with disease severity, with the solely cropped pepper having significantly the highest average severity (3.83) at 8WAT (Table 4). The result in Table 5 above shows the result of the analysis of the effect of treatment on days to flowering, days to fruiting, Number of fruits and weight of fruits. The treatments did not have any significant different on days to flowering and days to fruiting. The analysis of variance for the number of fruits per plant shows that treatment 3 (MPPM) had the highest number of fruits per plant (3.92) while treatment 1 (MPMP) had the significantly lowest number of fruits per plant (1.25). The analysis of variance for the weight of fruit per plant shows that significant differences existed between all the treatments. Treatment 3 (MPPM) also had highest fruit weight per plant (28.34) while treatment 5 (PPPP) produced significantly lowest weight of fruit per plant (13.62). Figure 1 shows the relationship between disease incidence and growth attributes. The higher the incidence of viral diseases the lower the number and weight of fruits.

Table 1. Effect of intercrop and crop arrangement on plant height of pepper at different weeks after transplanting.

	Plant Height in CM at different weeks after transplant (WAT)			
Treatment	**2WAT**	**4WAT**	**6WAT**	**8WAT**
1. MPMP	7.20	11.97	16.83	18.31
2. PMPM	6.27	12.95	18.74	24.71
3. MPPM	7.45	14.38	23.10	24.73
4. PMMP	7.62	12.85	19.69	25.04
5. PPPP	5.96	11.41	17.88	19.56
DMRT	NS	NS	NS	NS

Means followed by the same letters in a column are not significantly different at P $\leq$ 0.05 using the new Duncan Multiple Range Test.

Table 2. Effect of intercrop and crop arrangement on number of leaves of pepper at different weeks after transplanting.

	No of leaves at different weeks after transplant (WAT)			
Treatment	**2WAT**	**4WAT**	**6WAT**	**8WAT**
1. MPMP	7.41	10.92	16.33	17.25
2. PMPM	7.57	12.95	21.67	22.42
3. MPPM	8.37	19.58	29.25	30.33
4. PMMP	7.12	16.0	22.67	29.86
5. PPPP	6.92	12.33	29.00	31.37
DMRT	NS	NS	NS	NS

Means followed by the same letters in a column are not significantly different at P $\leq$ 0.05 using the new Duncan Multiple Range Test

Table 3. The effect of intercrop and crop arrangement on Incidence of viral diseases of pepper at different weeks after transplanting.

	Disease Incidence (%)			
Treatments	**2WAT**	**4WAT**	**6WAT**	**8WAT**
1. MPMP	0	6.25	12.50^{ab}	19.68^{b}
2. PMPM	0	0	6.25^{b}	14.58^{b}
3. MPPM	0	2.42	12.50^{ab}	22.92^{b}
4. PMMP	0	0	8.33^{b}	25.93^{b}
5. PPPP	0	10.42	44.58^{a}	70.83^{a}
DMRT	NS	NS		

Means followed by the same letters in a column are not significantly different at P $\leq$ 0.05 using the new Duncan Multiple Range Test.

Table 4. The effect of intercrop and crop arrangement on Severity of viral diseases of pepper at different weeks after transplanting (WAT).

	Average Disease Severity			
Treatments	**2WAT**	**4WAT**	**6WAT**	**8WAT**
1. MPMP	1	2.0	1.87	2.72^{b}
2. PMPM	1	1.0	2.0	2.0^{c}
3. MPPM	1	1.33	2.22	2.57^{b}
4. PMMP	1	1.0	1.89	2.57^{b}
5. PPPP	1	1.67	3.10	3.83^{a}
DMRT	NS	NS	NS	

Means followed by the same letters in a column are not significantly different at P $\leq$ 0.05 using the new Duncan Multiple Range Test.

Table 5. The effect of intercrop and crop arrangement on Days to Flowering, Days to Fruiting, Number of Fruits and Weight of Fruits of pepper at different weeks after transplanting.

Treatments	**Days to Flowering**	**Days to Fruiting**	**No of Fruits**	**Wt of Fruits (g)**
1. MPMP	60.92	73.92	1.25^{b}	14.67^{b}
2. PMPM	62.0	73.33	3.0^{ab}	16.84^{ab}
3. MPPM	57.83	69.77	3.92^{a}	28.34^{a}
4. PMMP	67.03	77.17	2.08^{ab}	18.47^{ab}
5. PPPP	60.83	72.25	2.33^{ab}	13.62^{b}
DMRT	NS	NS		

Means followed by the same letters in a column are not significantly different at P $\leq$ 0.05 using the new Duncan Multiple Range Test.

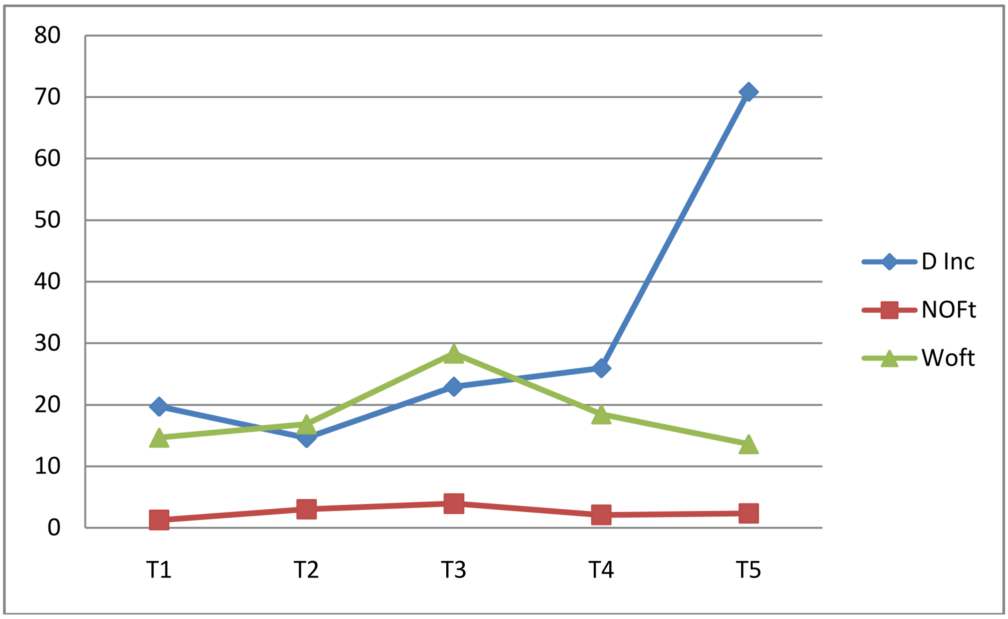

Fig. 1. Relationship between disease incidence and growth attributes.
D Inc= Disease incidence; NOFt= Number of fruits; Woft= Weight of fruits

DISCUSSION

Intercropping, the simultaneous cultivation of multiple crop species, has been used throughout history and remains common among farmers of small landholdings in the tropics. One benefit of this practice may be disease control. The mechanisms by which intercrops affect disease dynamics include alteration of wind, rain, and vector dispersal; modification of microclimate, especially temperature and moisture; changes in host morphology and physiology; and direct pathogen inhibition (Boudreau, 2013).

In this present study, viral disease incidence and severity were significantly higher in sole pepper compared with pepper intercropped with maize. The maize plants probably served as a barrier for the pepper plants from the invading insect vectors. Taiwan Agricultural research Institute (TARI, 1983) had earlier confirmed the use of intercropping pepper with corn in alternate rows to significantly reduce virus incidence compared with other treatments such as the use of reflective mulches, mineral oils, and insecticide sprays. Also intercropping with banker plants comprising with or barley or a tall companion crop like maize enhance the establishment of *aphid colulemani* and *aphid apidimyza* which predate on *aphid gossipi* (Mansour *et al*., 2000). Planting of pepper in mono-crop have been reported to lead to, higher incidence of potyviruse and unmarketable yields; and lower total and marketable yields in pepper fields compared with intercropping of pepper with maize (Ashenafi *et al*., 2013).

The use of maize as intercropping component of pepper is effective in protecting pepper fields from aphid infestation and infection by potyvirus. It results in improving the quality and quantity yield of pepper (Ashenafi *et al*., 2013). Fajinmi 2006 also stated that intercropping has effect of the population build up of insect pest and that it reduces the incidence of pest in cases where the crops used in intercropping are not hosting the same insect species in contrast, intercropping of crops that host the same insect pests increase the incidence of these pests.

Maize intercropped with pepper showed effective management control in reducing viral disease incidence in pepper with an increase in yield compared to sole pepper. The high disease incidence and severity in the sole pepper crop could have led to high significant reduction in crop yield compared with pepper yield in the intercrop. A similar observation was made Fuchs and Minzemayer (1995) that there could be >25% reduction in fruit yield in crops with high disease incidence and severity.

However many factors have to be taken into consideration before applying intercropping as an integrated approach in viral disease management. Successful crop mixtures in the intercrop share available resources over time and space in a way that they exploit variation between component crops in such characteristics as rate of canopy development, width, height, photosynthetic adaptation of canopies to radiation and rooting depth (Fajinmi, 2006).

CONCLUSION

From the result of this experiment, it can be concluded that intercrop and crop arrangement can influence viral disease incidence and severity as well as the yield of pepper. Sole pepper had both the highest viral disease incidence and average severity, it also produced the second lowest number of fruits per plant, and it had the least weight of fruits per plant. Finally, intercropping could be used to reduce the incidence of virus disease of pepper and at the same time give good yields.

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REFERENCES

Alagbejo , M. D., I. I. Uvah (1987). Effect of intercropping pepper with tall companion crops on the incidence of pepper vienal mottle virus on pepper.*Nig.J.Entomol*.7:82

Arogundade, O. 2012. Occurrence and Distribution of Viruses Infecting Pepper (*Capsicum sp*.) in Southwest Agro-Ecological Zone of Nigeria. Ph.D Thesis, University of Ilorin, Kwara State Nigeria.

Ashenafi Mitiku, Alemayehu Chala, Yibrah Beyene (2013). The Effect of Intercropping of pepper with maize and sweet potato on infection of pepper (*Capsicum annuum* L.) by potyviruse and yield of pepper in southern Ethiopia. *International Journal of Technology Enhancements and Emerging Engineering Research*, 1(4): 68-73

Fuchs,T.W. and R. Mizenmayer (1995). Effects of Aphis gossypii on cotton development and yield in West Texas. *Southwestern Entomologist*, 20:341-349

F. A. O. 2014. Year book of Agriculture Organization Statistics.2013,FAO of the United Nations.Rome.

Fajinmi, A. A. 2006. The incidence, spread and possible control strategies of *Pepper veinal mottle Potyvirus* (PVMV) disease on pepper (*Capsicum annuum.L*.) in Nigeria. Ph. D Thesis, University of Ibadan Oyo State Nigeria.

Mark A Boudreau (2013). Diseases in Intercropping Systems. *Annual Review of Phytopathology,* 51(1)

Mansour, A. N., M. Akkawi and A. Al-Musa 2000. A modification in Alluminium foil technique for controlling aphid- borne mosaic virus of squash. *Dirasat Agric.Sci*.27:1-9

Olaniyan, A.A., and Fawusi, M.O.A 1992. Growth response of pepper (Capsicum species L.) to various propagation media. NIHORT occasion paper no. 29

Olanrewaju J.D. and F.A showemimo 2002. Comparative analysis between maturity trait, yield components, and yield of tatasai pepper under constrasting condition Nig J. Hortic sci .7:33-37.

Racah B. and A. fereres, 2009. Plant virus transmission by insect. Encyclopedial, B. (ED). John wiley and son's ltd. UK

Salami, A.O. 1999. Biochemical interections of mycorrhiza and soil-borne microorganism on the growth of pepper (Capsicum ammum L.) seedlings. A Ph. D thesis submitted to university of Ibadan.

Silwana T.T and Lucas. 2002. The effect of planting combination and weeding and yield of component crops of maize bean and maize pumpkin intercrops J. Agric sci, 138: 193-200

Taiwan Agricultural Research Institute, 1983. Annual report. 1982. Taiwan Agricultural Research Institute, Winipeng, Taiwan.USA,PP.174

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