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Influence of Intercrops and Damage of Insect Pests on Cocoa Production in Ibadan, Oyo State

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Abstract: The effect of food crops intercropped with cocoa and compared with Cocoa monocrop on major insect pests of cocoa was investigated in Ibadan, Nigeria. The incidence of some insect pests of cocoa and the damages which they caused to the crop were monitored and assessed from 2011-2014 in a newly established micro plots of cocoa at Ibadan either planted alone or intercropped with yam, cassava, cocoyam, maize, melon, cowpea or okro that were established in the same year with cocoa seedlings. The food crops were used as a general shade plant for young cocoa in all the subplots.There were four cropping treatments comprising of Cocoa/maize/yam/cowpea; Cocoa/cassava/maize/melon; Cocoa/cocoyam/melon/okra and cocoa sole. Each treatment, was in four replicates which were laid out in a randomised complete block design (RCBD). The obtained result showed that the shoot feeding insects, *Earias biplaga, Anomis leona, Mesohomotoma tessmanni, Stictoccocus sjostedti* attacked young cocoa during the wet season of the first year of establishment compared with *Z. variegatus, S. singularis* and *M. bellicocus* that were abundant in the dry season while *T. aurantii, P. njalensis* and *C. stictigrata* were prevalent through out the seasons (wet and dry). Various insect species attack cocoa during its diferent stages of growth, causing considerable damage to the seedlings in successive years. The T- test "t" values separate the significant damages among the intercrops, in the successive years. There was significantly positive correlation between percent damage/survival and superiority in growth of cocoa seedlings. The relative numbers of each insect pest species and the percentage of cocoa seedlings per plot varied with the food crop intercropped with cocoa and the cocoa intercropped with cocoyam was the least attacked by insect pests. Therefore, cocoa/staple food intercropping using cocoyam as one of the component arable crops could be developed into an Insect Pest Management package for cocoa production in Ibadan locality of Nigeria.

Key words: Intercropping · Insect · Integrated · Package · Damage

INTRODUCTION

Inter cropping is the cultivation of two or more crops at the same time in the same field. Its advantages are risk minimization, increased income and food security, reduction of soil erosion and pest and disease control. Rao and Morgado [1] Natarajan and Willey, [2] have shown that inter cropping can give rise to substantial increases in yield because the component crops complement each other and make better use of environmental resources than when grown separately. There is reduction of insect/mite pest populations due to the diversity of crops grown and reduction of plant diseases because the distance between planting of the same species is increased due to the planting of other crops between them, alteration of more beneficial insects especially when flowering crops are included in the cropping system increase of total farm production and profitability and reduction of weed population through allelopathy and efficient crop production [3]. Adeyemi, [4] reported that intercropping reduced weeding period of cashew by about 50% when compared to sole cashew. Therefore, when cashew was intercropped with maize, cassava, cowpea and melon its morphological growth parameters were not affected except the girth that was slightly reduced under cashew/cassava mixture [5]. Famaye and Adeyemi, [6] reported that cashew sole gave highest weed biomass closely followed by cashew/rice and then cashew/plantain. However, there was no significant

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difference between the sole cashew, cashew/rice and cashew/plantain intercropped.

The micro-environment of a crop can also be altered in such a way that the sequence or pattern of the crop in the ecosystem is changed in order to influence or modify the insect's habitat and thus interfere with its responses to the host [7, 8]. Many farmers in the tropics practise companion cropping [9] involving a few to several crops. Studies on the effect of companion cropping on insect pests have been performed in cowpea-maize, cowpea-sorghum and cowpea-cassava associations [10]. In Nigeria, cocoa farmers intercrop young cocoa farms and mix-crop mature cocoa farms with food crops such as maize (*Zea mais*), cassava (*Manihot esculenta*), cocoyam (*Colocasia esculentum*), yam (*Dioscorea* spp.), cowpea (*Vigna unguiculata*) and fruit-vegetables such as okra (*Hibiscus esculentus*), garden-egg (*Amaranthus viridii*), melon (*Citrutus vulgaris*) and peppers (*Capsicum spp.*), primarily to maximize land use, produce some food for family consumption and generate some revenue before the cocoa trees start bearing [11]. The cocoa farms may be intercropped for consecutive three or four years immediately after transplanting the cocoa seedlings. Sometimes, open spaces (gaps) in mature cocoa farms created by the death of cocoa trees or permanent shade trees, are filled with food crops and young cocoa. The extent to which the various intercropping and mix-cropping practices influence insect pests of cocoa and the damage they caused to the young cocoa in the absence of insecticides application, which is yet to be investigated.

This study examines the effect of intercropping some Nigerian staple food crops with young cocoa, on the succession and abundance of major cocoa insect pests and the damage which the pests could cause to young cocoa were studied in Ibadan, a major cocoa growing area of Nigeria. The present study was therefore designed to explore the effectiveness of food crop and cocoa intercrop in the management of cocoa insect pests.

MATERIALS AND METHODS

Young hybrid cocoa plots established recently under plantain (Musa spp.) as temporary overhead shade, was intercropped with various combinations of food crops annually for four consecutive years. The intercropping combinations adopted were (1) cocoa/ cocoyam/ melon/ okra (2) cocoa/ cassava/ maize/ melon (3) cacoa/ maize/ yam/cowpea and (4) cocoa only. The combinations adopted were based on Nigerian cocoa farmers intercropping practices. The experimental block was surrounded by plots of mature hybrid cocoa. The experiment was laid out in a randomized complete block design (RCBD), with each treatment replicated four times. The size of each subplot was 30 x 36m and contained 120 young cocoa stands planted as 3 x 3 m^2. Annually, the food crops were replanted at the beginning of the early rains until the closing up of the cocoa canopy did not permit further intercropping of cocoa with food crops. The succession and number of major insect pests of cocoa and the damage which they caused to cocoa under treatment were monitored weekly. The trials were conducted from 2011-2014 at Ibadan, which is a major cocoa producing locality of Nigeria.

All data collected were subjected to Analysis of variance (ANOVA) and significant means separated using Duncan new multiple test. T- test values of relative damages were calculated, while correlation analysis was carried out to determine the relationship between damage and superiority in growth of seedling under intercrop to cocoa sole.

RESULTS AND DISCUSSION

Table 1 showed the common insect pest species identified in the study location. The result showed that the shoot-feeders, *E. biplaga, A. Leona, M. tessmanii, S. sjostedti* and *B. thalassina* attacked young cocoa during the wet season of the first year of establishment compared with *Z. variegatus, S. singularis, M. bellicocus* that were abundant in the dry season while *T. aurantii, P. njalensis* and *C. stictigrata* were prevalent through out the season (wet and dry). Various insect species attack cocoa during its diferent stages of growth, causing considerable damage to the seedling in successive years. Young cocoa growing as sole crop under plantain shade was attacked by myriad of insect pests particularly shoot-feeders which devoured leaf buds, young flushes, un-hardened old leaves, bark of stem and pericarp of cocoa pods. This is in agreement with the report of Okigbo and Greenland, [9] that many farmers in the tropics practise companion cropping involving a few to several crops. From the results, these trials showed that infestation and damages by these insect pests could be reduced by intercropping the very young cocoa with some food crops. Rao and Morgado, [1]; Natarajan and Willey, [2] have shown that inter cropping can give rise to substantial increases in yield because the component crops complement each other and make better use of environmental resources than when grown separately. Adeyemi, [4] reported that intercropping reduced weeding period of cashew by about 50% when compared to sole cashew. There is

Table 1: Insect species identified at the experimental site (CRIN Headquarters, Ibadan)

Insect species	Wet season	Dry season
Earias biplaga	+	-
Anomis leona	+	-
Mesohomatoma tessmanni	+	-
Sahlbergella singularis	-	+
Zonocerus variegatus	-	+
Macrotermes bellicosis	-	+
Toxoptera aurantii Fan.	+	+
Planococcus njalensis Laing	+	+
Stictoccocus sjostedti Clk	+	-
Characoma stictigrapta Hmps	+	+
Bathycoelia thalassina	+	-

+ presence of insect
- absence of insect

Table 2: The effect of intercropping on plant growth, development and survival of cacao seedling

	2011				
Treatment	Height	Growth	Leaf no	Leaf area	% survival
Cocoa/yam/maize/cowpea	57.55^{b}	1.11^{c}	50^{c}	143.48^{c}	63.33^{a}
Cocoa/cassava/ maize /melon	58.67^{b}	1.11^{c}	65^{b}	174.54^{b}	56.67^{b}
Cocoa/cocoyam /okro /melon	77.80^{a}	1.43^{a}	75^{a}	211.47^{a}	63.33^{a}
Cocoa sole	59.40^{b}	1.37^{b}	47^{d}	148.16^{c}	56.67^{b}

Table 3: The effect of intercropping on plant growth, development and survival of cocoa seedlings

	2014				
Treatment	Height	Growth	Leaf no	Leaf area	% survival
Cocoa/yam/maize/cowpea	212.5^{a}	3.72^{a}	100.0^{c}	374.4^{a}	90.00^{ba}
Cocoa/cassava/ maize /melon	193.2^{ba}	3.20^{c}	121.0^{b}	251.6^{c}	93.33^{a}
Cocoa/cocoyam /okro /melon	199.1^{ba}	3.50^{b}	151.0^{a}	366.7^{b}	90.00^{ba}
Cocoa only	175.6^{b}	3.00^{c}	95.4^{c}	366.6^{b}	86.67^{b}

Table 4: Mean percent damage by major insect pest of cocoa

	% Damage		
Treatment	2011	2014	"t" Test values
Cocoa/maize/yam/cowpea	73.33	65.55	2.75 NS
Cocoa/cassava/maize/melon	66.67	56.57	3.57 Sig
Cocoa/cocoyam/melon/okra	73.33	65.55	2.75 NS
Cocoa only	66.67	56.57	3.57 Sig

Table 5: Correlation coefficient of damage, survival and morphological growth of cocoa seedlings

Treatment	Height	Number of leaves	Leaf area
Damage	0.6673***	0.6127***	0.6546***
Growth	0.9806***	0.8465***	0.8961***
%Survival	0.9078***	0.8060***	0.7890***

*** Significant ($p<0.05$)

reduction of insect/mite pest populations due to the diversity of crops grown and reduction of plant diseases because the distance between planting of the same species is increased due to the planting of other crops between them, alteration of more beneficial insects especially when flowering crops are included in the cropping system increase of total farm production and profitability and reduction of weed population through allelopathy and efficient crop production [3].

Cacao/cocoyam/okro/melon intercrop recorded significantly highest height (77.80) compared with other intercrop including the monocrop (sole cacao). Furthermore, the crop combination of Cocoa/ cocoyam/ okro/ melon recorded significantly higher growth (1.43) than other combination and sole (cocoa only). The cocoa/cocoyam/okro/melon had higher number of leaves (75) compared with other intercrop while the cocoa sole had the least (47). Cocoa/cocoyam/okro/melon recorded significantly the highest leaf area compared with other crop combinations while cocoa/yam/maize/cowpea recorded the least though same values with cocoa sole. Percentage of survival of seedlings was significantly higher in both intercrops of cocoa/cocoyam/okro/melon (63.33) and cocoa/yam/maize/cowpea (63.33) compared with cocoa/cassava/maize/melon (56.67) and cacao sole (56.67) (Table 2). Among the intercrops, the cocoa/cocoyam/melon/okro had the least insect pest damage. However, cocoyam and cassava have been recording negative impact in most of the trial involving intercropping system which included the two crops. Two probable reasons could be adduced for this. Firstly, the two crops provided extra overhead shade to young cocoa growing under them for most of the year, particularly during the dry season when young cocoa was more susceptible to drought. Secondly the two crops, because of their broad leaf blades constituted physical barriers or baffles to insect pests in search of their primary host, which in this instance was young cocoa. The micro-environment of a crop can also be altered in such a way that the sequence or pattern of the crop in the ecosystem is changed in order to influence or modify the insect's habitat and thus interfere with its responses to the host [7, 8].

Table 3 showed that combination of Cocoa/ yam/ maize/ cowpea recorded significantly highest height (212.80) compared with other combination while the sole cocoa recorded the least (175.6). Also, cocoa/yam/maize/cowpea had significantly higher growth (3.72) compared to other combinations whereas sole recorded the lowest growth (3.00) values. The intercrop of cocoa/cocoyam/okro/melon had higher number of leaves

(151.0) compared with other intercrop while the cocoa sole had the least (95.4). Cocoa/yam/maize/cowpea recorded significantly highest leaf area compared with other crop combinations including the sole cocoa though cocoa/yam/maize/cowpea had the least. The higher susceptibility of cocoa/maize/yam/melon and cocoa/cowpea/maize/melon to the pests, among the three intercrops could be attributed to the fact that maize, melon, cowpea and okro apart from their stand geometry could not provide extra shade required to protect cocoa during the dry (critical) season because these food crops grow mainly during the wet season. In this study, melon, okro and early maize carried fresh foliage during the wet season and they are usually harvested before the onset of the dry season. Significantly higher percent survival of seedlings was recorded in the combination of cocoa/cassava/maize/melon (93.33) compared with other combinations while cocoa sole had the least value (86.67). This could be attributed to the less number of mirids, *S. singularis* located on the cocoa/cocoyam/melon/okro and cocoa/cassava/maize/melon intercrops. Similarly, other important pests of cocoa, especially, *E. biplaga, M. tessmanni, P. njalensis* and *M. bellicosus* in various treatments was similar throughout the experimental period. However, insect pests moving out from the neighboring mature cocoa plantations to the newly established cocoa identified and infested their primary host (cocoa) more easily under the sole planting than under the intercrops.

The T -test values (3.57) separate the significant damage among intercrop, cocoa/cassava/maize/melon and cocoa sole in the successive years. Whereas other crop combinations were not significant at T-test value (2.75) (Table 4). Furthermore the extent to which the pests damaged young cocoa stands also varied with the type of food crops intercropped with cocoa. Thus, the foliage of cocoa established sole was more heavily devoured than those of cocoa established as intercrops. This is corroborated by the studies on the effect of companion cropping on insect pests in cowpea-maize, cowpea-sorghum and cowpea-cassava associations [10].

Table 5 showed that there was significantly positive correlation between the percent damage/survival and superiority in growth which by extension determined by the height and growth of seedling. The higher height, number of leaves and leaf area had been implicated to measure steady growh of the cocoa seedling. However, insect pest damage was positively correlated at a lower coefficient.

CONCLUSIONS

Among the intercrops, the use of cocoyam as one of the component arable crops would be ideal for Ibadan area. Therefore, cocoa/staple food intercropping with cocoyam could be developed into an insect pest management package for cocoa production.

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