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Assessing the Impact of Biodiversity Conservation in the Management of Maize Stalk Borer (*Busseola fusca,* F.) in Nigeria

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Abstract - Maize is a staple food crop for most households in Nigeria and is grown in almost all agro-ecological zones. Unfortunately maize yield is too low to keep pace with the rate of population growth, leading to serious food insecurity and poverty. The low yield is associated with incidences of stem borers. The impact of intercropping maize with bambara groundnut in the management of African maize stalk borer, (*Busseola fusca*, Fuller Lepidoptera:Noctuidae) were assessed in Nigeria during 2009/2010 farming seasons. The results showed that maize plots intercropped with bamabara groundnut significantly reduced the larval densities, number of stem bored and percentage dead heart compared to maize monocrop in both seasons respectively. Buildups of natural enemies of the borer were observed to be higher in plots that were intercropped than in the control/sole and contributed in the reduction of stem borers infestations. Equally, the total grain yields were significantly higher under plots that were intercropped compare to plots under monocrop. Intercropping system has the additional advantage of higher land productivity than the monocrop. In conclusion intercropping maize with bambara groundnut improved; biodiversity of the ecosystem, stem borers management and increased maize yield.

Keywords - Biodiversity conservation, farming system, maize stem borer management, yield.

INTRODUCTION

Maize is one of the most important cereal food crops in Nigeria, and in many parts of Africa [1],[2]. Unfortunately maize production in Nigeria is characterized by poor resource farmers with limited access to land, technology and capital with resultant low yield. Maize yield is too low to keep pace with the rate of population growth, leading to serious food insecurity and poverty [3]. The low yield is associated with incidences of stem borers and low adoption of crop management package technologies that can reduce yield losses thereof. Every effort made so far to improve maize yield has not given the desired results because of pre- and post harvest losses due to biotic factors [4].

Among the most important biotic constraints to maize production is insect infestation [4]. Of the various insect pests attacking cereal crops in Africa, Lepidopteran stem borers are by far the most injurious [5] - [7]. Stem borers infestations have seriously limited the attainable yield potential of maize across maize producing regions of the world.

Of the seventeen stem borer species that attack cereal plants in Africa, *Busseola fusca* Fuller (Lepidoptera: Noctuidae), *Sesamia calamistis* Hampson (Lepidoptera: Noctuidae), and *Eldana saccharina* Walker (Lepidoptera: Pyralidae) are of greatest importance species that attack maize plant [7]. *Busseola fusca* is an indigenous stem borer species that attack many cereal crops and the most important stem borer species in Nigeria. Its distribution and pest status varies according to the altitudes and is more severe in the higher altitude than lower ones [8]. The female adults lay its eggs mainly on young plants and on unfolded leaf.

The stem borer attacks the plant from the vegetative stage through maturity. The larvae feed on the young leaves and tunnels made at the primordial point of growth severe the growing point of the plant resulting in a condition called dead-heart. When it attacks the stem, tunneling by the larvae on plants dislodges nutrient circulation and photosynthesis resulting in early leaf senescence, stunting of the plant, grain malformation and reduced grain yield [1], [2].

The yield losses caused by stem borers to maize vary widely in different places depending on prevailing factors, but are typically in the range of 20-40% of the potential yield [5], [9]. It have equally been reported that when maize grains are damaged by pests such as stem borers, it becomes susceptible to infection by pathogens such as *Aspergillus*, thereby increasing the total loss [10].

The high stem borer infestations being observed in the recent time may be attributed to reduction in biodiversity in agro-ecosystems in the last decades following intensification of cereal agricultural systems. Research results have shown that manipulation of agro-ecosystems to enhance the overall biodiversity have relatively fewer pest problems [4]. Farming practices that conserve such biodiversity as ground fauna and pests' natural enemies may be a practical alternative to manage pests in agricultural systems.

Consequently, the adoptions of locally available technologies in the management of stem borers in Africa

have been stressed [2]. It is the most relevant and economic method of stem borer control available for resource-poor farmers in Africa [7]. Although cultural control options like intercropping for stem borer management appear promising, most African farmers have not adopted them [11].

Hence evaluating available intercrop options to exploit the benefit of controlling maize pests would serve as a strategy for improving maize protection and grain yield. Thus in this study, we assessed the beneficial impacts of intercropping maize with bambara ground nut (which is generally considered to be pest resistant) in the management of *Buseola fusca* stem borer incidences on maize.

MATERIALS AND METHODS

Field experiments were conducted at Ebonyi State University Research Farm during 2009 and 2010 farming seasons to evaluate the effect of intercropping maize with bamabara groundnut in the management of stem borer for improved maize yield. The experiments were laid out in randomized complete block design with three replications. Two spatial arrangements were used in the intercrops; i) a within row arrangement where each maize plant was followed by a bambara groundnut and ii) strip planting in which two rows of maize were followed by two rows of bamabara groundnut crop, with one row of bamabara groundnut as first and last row borders in a $20m^2$ plot each. Each experiment has control plot with insecticide treated to allow an estimation of yield losses due to stem borers attack. Data were collected from 12 randomly selected maize plants per plot fortnightly for the assessment of plant damage (% stem bored and % dead-heart) and borer larval abundance. Sampling started 30 days after planting (DAP) and continued till maturity of maize. At each sampling date, four maize plants were dissected and borer larvae, pupae and any natural enemy (seen within or outside the maize plant) were identified to species and counted per plant per plot. Corn yield was assessed at maturity by randomly selecting 100 ears from each plot and examining them for insects and insect-related damage. Related damage was rated visually on a scale (1-3). Collected data were analyzed using [12]. Land Equivalent Ratio (LER) was estimated to test the productivity of the mixture according to [13].

RESULTS AND DISCUSSION

The results showed that intercropping has significant influence on the incidence of *B. fusca*. The maize plots intercropped with bamabara groundnut significantly reduced the larval densities, number of stem bored and percentage dead heart compared to maize monocrop in both seasons respectively (Table 1). This is in line with the result reported by [14]. According to him when maize was intercropped with cassava in Nigeria, its effect reduced the larval numbers of *E. saccharina*, *B. fusca*, and *S. calamistis* populations by half. Field trials in Eritrea showed that when sorghum was intercropped with haricot beans, cowpea, desmodium and Dolichos lablab the incidences of dead heart were much lower compared to pure stand sorghum [15]. Similarly, such results have been reported by [4]. According to them when maize was intercropped with non-host crops (e.g. cassava and grain legumes), the incidences of stem borers/damage were significantly reduced following higher level of parasitism recorded under mixed cropping than monocrop maize.

The results showed more abundance of natural enemies of *B. fusca* under intercropped plots than under the monocrop plots (Table 2). Of all the natural enemies recorded *Cotesia sesamiae* that attack the larval was the most common parasitoid encountered, followed by the predatory ants, others were the parasitic wasps and parasitic flies. However, parasitic wasps that may attack eggs were the most important (e.g. *Trichogramma* spp. and *Telenomus* spp.) or caterpillars (e.g. *Bracon* spp and *Cotesia sesamiae*). Similar results have been reported in Kenya in the recent time by [16], [17]. According to them, when maize was intercropped with the no host molasses grass, *Melinis minutiflora* the borer incidences were highly reduced through the activities of natural enemies. According to them, volatile agents produced by the molasses grass repelled stem borers but attracted foraging *C. sesamiae*, which also has more sources of food under intercrop.

The result showed that total grain yields were significantly higher under plots that were intercropped compare to plots under monocrop, while the percentages yield losses due to stem borer's infestations were significantly lower in intercropped plots than in monocrop respectively for both seasons (Table 3). In studies carried out in Cameroon, maize monocrops had 3 to 9 times more stems tunneled and 1 to 3 times more cob damage than maize intercropped with non-host crops such as cowpea, cassava and soybean, which resulted in a higher yield in the intercropped maize [7]. The increase in yield loss recorded under monocrop compare to intercropped maize in this study is in line with the results reported by [4]. According to them, maize yield losses due to stem borers were about 2 to 3 times higher in monocrops than in intercrops. A recent study in Cameroon found that stem borers, primarily *B. fusca*, were responsible for a 9-g loss in grain yield per plant per borer and caused 11% loss of plants owing to dead heart [18]. The 2:2 maize/ bambara intercrop produced significantly higher number of cobs, number of seeds and seed weight (total grain yield) with less infestation than 1:1 maize/ bambara intercrop (Table 3). This confirms the report by Singh, and Ajeigbe (2002) that strip cropping system involving two rows of densely planted cereal and four rows of densely planted cowpea appeared to be significantly more productive than the traditional practice of one row cereal by one row of cowpea. Similarly, the results on grain yield showed that intercropping system has the additional advantage of higher land productivity than the monocrop (Table 3). This is in line with the results reported by (Chabi-Olaye et al., 2006). The net production of mixed cropping systems was economically superior to controlling stem borers with insecticide in monocropped maize. The higher yield recorded under the intercrop may be

attributed to the role of intercropping in increasing the fertility of the soil [20]. It has also been reported that colonization of the maize plant by borers, severity of infestation and damage strongly depend on the cropping system and soil fertility, which affects the nutritional status of the plant as observed under the present result [21], [22].

The significant higher Land Equivalent Ratio (LER) values (greater than 1.0) recorded in both years showed the advantages of intercropping systems over monocrop (Table 4). The yield increase might probably be due to the advantageous effects of legume in increasing nutrient level of the soil for the maize, thus using local available inputs that are at the disposal of the resource-poor maize farmers for sustainable crop protection for an enhanced food security and gross benefits in environmentally sustainable manner.

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Table 1: Effect of intercropping maize with bambara nut on mean number of number of larvae, stem bored and dead heart by *B. fusca* under different planting system for 2009/10 farming seasons.

Treatments	Percentage infestation					
	2009			2010		
	No. of larvae	No.stem bored	No.dead hearts	No.of larvae	No.stem bored	No.dead hearts
BN/Maize (1:1)	16.6b	6.9b	12.3c	13.9b	7.1b	6.3b
BN/Maize (2:2)	11.5c	6.2b	13.5b	10.1c	5.5b	5.2b
BN/Maize(1:1) control	1.3d	5.3c	6.7d	0.9d	2.1c	0.9c
BN/Maize(2:2) control	0.7e	3.5d	2.9e	0.0d	0.3c	0.0c
Sole maize	25.8a	26.1a	29.8a	24.6a	25.2a	28.9a

Means followed by the same letter(s) in the same column do not differ significantly (SNK-test, $P \leq 0.05$).

Table 2: Mean Population of different natural enemies of *B. fusca* under different planting system for 2009/10 farming seasons.

Treatment	Mean abundance of natural enemies									
	2009					2010				
	C. sesamiae	**predatory ants**	***Trichogramma* spp.**	***Telenomus* spp**	***Bracon* spp**	***C. sesameae***	**predatory ants**	***Trichogramma* spp.**	***Telenomus* spp**	***Bracon* spp**
BN/Maize (1:1)	17.3	13.1	9.3	-	1.5	13.2	12.9	7.1	-	1.1
BN/Maize (2:2)	19.1	15.3	11.1	3.3	2.3	17.5	14.2	8.3	2.4	2.1
Maize sole (control)	9.7	7.7	5.7	-	-	6.9	6.8	3.3	-	-

Table 3: Effect of intercropping maize with bambara nut on total grain/ percentage yield loss under different planting system for 2009/10 farming seasons.

Treatments	Grain Yield			
	2009		2010	
	Total grain yield (t ha^{-1})	**% yield loss**	**Total grain yield (t ha^{-1})**	**% yield loss**
BN/Maize (1:1)	2.7b	12.9	2.5b	10.7
BN/Maize (2:2)	2.9b	12.1	2.8a	6.7
BN/Maize(1:1) control	3.1a	38.7	2.8a	39.3
BN/Maize(2:2) control	3.3a	42.4	3.0a	43.3
Maize sole	1.9c		1.7c	

Means followed by the same letter(s) in the same column do not differ significantly (SNK-test, $P \leq 0.05$).

Table 4: Effect of intercropping maize with bambara nut on Land Equivalent Ratio under different planting system for 2009/10 farming seasons.

Treatments	Land Equivalent Ratio	
	2009	**2010**
BN/Maize (1:1)	1.1b	1.1b
BN/Maize (2:2)	1.1b	1.1b
BN/Maize (1:1) (control)	1.6a	1.6a
BN/Maize (2:2) (control)	1.7a	1.8a

Means followed by the same letter(s) in the same column do not differ significantly (SNK-test, $P \leq 0.05$).