EFFECTS OF LAMBDA-CYHALOTHRIN AND CARBOFURAN ON POPULATION DENSITY OF *Orseolia Oryzivora* IN RELATION TO ITS PARASITOIDS ON RICE.

Mohammed I. G.[1], Osipitan, A. A.[2], Pitan O. R[2].,Adigbo, S.O[3].
[1]National Cereals Research Institute, Badeggi, Niger state.
[2]Department of Crop Protection, Federal University of Agric., Abeokuta, Ogun State
[3]Department of Plant Production and Crop Physiology, Federal University of Agriculture, Abeokuta, Ogun State
Corresponding author Email: babaisakoko@yahoo.com

ABSTRACT
Rice is an important crop that satisfies the nutritional needs of human being worldwide. The low yield of rice however, has been attributed to insect pests damage. *Orseolia oryzivora*is a serious insect pest of rice and use of insecticides in its control cause destruction of biodiversity. An experiment was conducted at field of National Cereals Research Institute, Badeggi Niger State to evaluate combined effects of lambda-cyhalothrin and carbofuran on population density of *O. oryzivora* in relation to its parasitoids on rice. The experiments was split-plot arranged in Randomized Complete Block Design, replicated three times. The means were separated using Student Newton-keul test (SNK). Data were collected on number of tiller per hill, plant height, days to 50% flowering, % incidence and severity of *O. oryzivora*, % parasitism of *O. oryzivora*, panicle per meter square, grains per panicle and yield of rice. Rice plants in plots treated with 0.38 L/ha lambda-cyhalotrin+ 3.75 kg/ha of carbofuran had significantly ($p<0.05$) lower incidence (1.37) and severity (1.46) compared with incidence (2.37-7.77) and severity (2.77-7.29) in plots treated with lambda-cyhalotrin0.38L/h + carbofuran2.5kg/ha, lambda-cyhalotrin3.75L/h + carbofuran0.25kg/ha and single application of lambda-cyhalotrin and carbofuran. Also rice plants treated with0.38 L/ha lambda-cyhalotrin+ 3.75 kg/ha of carbofuran had significantly ($p<0.05$) higher yield compared to other treatments.In conclusion, combined application of lambda-cyhalothrin and Carbofuran had complementary effect in the control of *O. oryzivora.*

Key Words:*Oryza sativa*, *Orseolia oryzivora*, lambda-cyhalotrin, carbofuran, synthetic insecticide

INTRODUCTION

Rice (*Oryza Sativa*) is a staple food in many countries of Africa and other parts of the world. It is classified as the most important food depends upon by over 50% of the world population for about 80% of their food need (Udemezue 2014). Sequel to the growing importance of the crop, FAO estimated that annual rice production should be increased from 586 million metric tons in 2000 to meet the projected global demand of about 756 million metric tons by 2030 (F.A.O 2000; Udemezue, 2014). West Africa, account for 64.2% of total rice production and consumption in sub-Saharan Africa. In west Africa, Nigeria ranks highest as both the producer and consumer of rice in the sub-region (Imolehin and Wada 2000). The annual rice production in Nigeria has increased from 5.5 million tons in 2015 to 5.8 million tons in 2017. Consumption had increased because of increased local production of the commodity. The consumption rate now is 7.9 million tones and the production rate has increased to 5.8 million tons per annum (RIFAN 2017). Rice is produced and utilized in several ways. The kernels are dissolved and used in the manufacture of glue. Rice starch is often incorporated into beers. Paints are made of powdered rice. The dried stems are used in feeding animals and making straw hats and sandals (Linares, 2002). Despite rice becoming an important cereal and staple food crop its production in Africa is still the lowest in the world and cannot meet the increasing demand for rice in many African countries (Hossain, 2006). Thus Africa is accounts for 32% of global rice imports in 2006 (Akinbile *et al.*, 2007; AfricaRice, 2008). The production-consumption gap in this region is due to low yield of rice (AfricaRice, 2008). This situation is due to both abiotic and biotic constraints on rice production, and many technical, management, socioeconomic, health, and policy constraints that restrict rice production (Balasubramanian *et al.*, 2007). In Africa, rice is affected by a wide range of abiotic and biotic factors that harm productivity. The abiotic constraints include: drought, flooding and variable rainfall, extreme temperatures, salinity, acidity/alkalinity and poor soils, soil erosion and high phosphorus fixation. The biotic constraints include weeds, blast leaf spots, Nematodes (Coyne *et al*., 2004). Termites are critical in some areas, rodents and birds damage rice crops in all ecosystems. Stem borers, leaf hoppers and rice midges are the major insect pests (AfricaRice, 2008). African rice gall midge (AfRGM) *Orseoliaoryzivora* Harris and Gagné (Diptera: Cecidomyiidae), appears to be the most serious insect pest of lowland and irrigated rice in the recent times (Ogah *et al.*, 2005, 2006; Nwilene *etal*., 2006). *Orseolia*. *oryzivora* is an insect pest indigenous to Africa (Harris *et al*., 1999). Since the establishment of its existence as a distinct species from the Asian rice gall midge *Orseoliaoryzae* (Wood - Mason), its pest status and distribution have been on the increase. African rice gall midge attacks rice at the vegetative stage and destroys the growing primordia, resulting in the formation of a tubular gall or onion shoot. Any tiller bearing a gall is irreversibly damaged and does not produce new leaves or panicle (Ogah *et al*., 2010). Losses caused by this pest have reached 80% and total crop failure is common in endemic areas (Heinrichs and Barrion, 2004**).** Many indigenous bio-control agents have been recorded in the field for the control of AfRGM. Of all the natural enemies of AfRGM, the most common parasitoid in Nigeria is *Platygasterdiplosisae* Risbec (Hymenoptera: Platygastridae) and *Aprostocetus procerae* (Nwilene 2006, WARDA-AfricaRice 2000; Ogah, *et al* 2010). *Platygasterdiplosisae* is an indigenous and gregarious egg-larval endoparasitoid of AfRGM. It lays its eggs within the gall midge eggs or neonate larva on plant surfaces (Nacro 1994). The adults then emerge from the fully-grown corpse of the gall midge larva. It can parasitize up to 80% of galls on rice plants, but mostly towards the end of the wet season and so fails to prevent economic damage (Ogah *et al* 2010). The objective of the study were; To assess effect of insecticide application combination on population density of African rice gall midge (AfRGM) *Orseoliaoryzivora* and To determine intensity of parasitism of African rice gall midge (AfRGM) *Orseoliaoryzivora* by parasitoids (parasitized larvae and pupae).

MATERIALS AND METHODS

This study was carried out at the Research field of National Cereals Research Institute, Badeggi Niger State in 2016 and 2017 cropping season. The experiment was laid out in split-plot fitted in to Randomized Complete Block Design, replicated three (3) times. The main plot treatments consist of two (2) rice varieties (FARO37 Susceptible variety and FARO 51 Resistant variety). While, sub-plot treatments were lambda-cyhalothrin (0.75 L / ha), carbofuran (7.5 kg / ha) and combination of their two reduced rates and the control to make six sub-plots: 0.38 L lambda-cyhalothrin / ha + 3.75 kg of carbofuran / ha, 0.38L lambda-cyhalothrin / ha + 2.5 kg of carbofuran / ha, 3.75 kg carbofuran / ha + 0.25 lambda-cyhalothrin / ha and the control treatment (no any application). Land preparation was done manually. Seedlings were maintained in nursery bed for 21 days when they were ready for transplanting. Transplanting was done at 1 seedling per hill. Seedlings were planted in rows at spacing of 20 cm x 20 cm inter- and intra- plant spacing. Fertilizer was applied at the rate of 40 kg/ha of N, P_2O_5 and K_2O. Weeding was done manually twice at 21 and 40 days after transplanting Data were collected on the following parameters. Tiller count, Plant height Number of days to 50% flowering, Panicle count, Grains per panicle, Grain yieldTwenty hills of rice were randomly selected per plot for assessing the incidence and severity of damage due to AfRGM (tillers with galls) at 21, 42 and 63 days after transplanting, according to standard evaluation system of International Rice Research Institute (IRRI, 2002).The damage injury rates were calculated as follow:

$$\text{Incidence} = \frac{\text{No. of hills with galls}}{\text{Total no. of hills}} \times 100$$

$$\text{Severity} = \frac{\text{No. of tillers with galls} \times 100}{\text{Total no. of tillers}}$$

African rice Gall midge Parasitism by parasitoids were recorded by dissecting twenty (20) galls formed from each treatment to check for presence of parasitised larva and pupae. Collected data were subjected to analyses of variance (ANOVA) Arcsine transformation was carried out on percentage tiller infestation and % parasitism data prior to ANOVA (SAS, 2003). The significant means were separated using Student Newman Keuls Test, (SNK).

RESULTS

Tiller count

There was significant ($P<0.05$) difference in tiller count, between the two varieties evaluated. FARO 37 had significantly ($P<0.05$) higher tiller count compared to FARO 51 (Table 1). There was no significant ($P>0.05$) difference in tiller count among rice plots treated with Lambda-cyhalothrin at rate of 0.75L/ha, Carbofuran at rate of 7.5 kg/ha, Lambda-cyhalothrin at rate of 0.38L/ha + Carbofuran 3.75kg/ha, Lambda-cyhalothrin at rate of 0.38L /ha+ Carbofuran 2.5kg/ha, Carbofuran at rate of 7.5 kg/ha+ Lambda-cyhalothrin at rate of 0.25L/ha and the control plot.

Plant Height

FARO 51 had significantly ($P<0.05$) taller plant compare to FARO 37 in both 2016 and 2017 cropping seasons. There was no significant ($P>0.05$) difference in plant heights, among rice sprayed with various rates of (Table1).

Table 1: Tiller count, plant height and days to 50% flowering as influence by Lambda-cyhalothrin+ Carbofuran combined Application

Treatments	Tiller count			Plant height			50% flowering		
	2016	2017	Mean	2016	2017	Mean	2016	2017	Mean
Variety(V)									
FARO 37	16.67 a	16.89 a	16.78	98.46 a	98.21 a	98.36 a	90.56 a	90.67 a	90.62 a
FARO 51	14.17 b	14.38 b	14.27	96.04 b	95.74 b	95.89 b	84.67 b	85.06 b	84.87 b
Insecticide Application(I)									
Lambda-cyhalothrin, 0.75L/ha	15.67 a	15.83 a	15.75 a	97.08 a	96.78 a	96.93 a	93.50 b	93.33 c	93.42 a
Carbofuran, 7.5 kg/ha	15.33 a	15.33 a	15.33 a	97.10 a	96.93 a	97.02 a	94.33 a	94.17 b	94.25 a
Lambda-cyhalothrin,0.38L/ha+Carbofuran3.75kg/ha	15.17 a	15.33 a	15.25 a	97.22 a	97.03 a	97.13 a	77.33 d	78.18 f	77.72 d
Lambda-cyhalothrin,0.38L/ha+ Carbofuran 2.5kg/ha	15.33 a	15.67 a	15.50 a	96.70 a	96.70 a	96.70 a	82.83 c	82.83 e	82.83 c
Carbofuran 3.75kg/h+ Lambda-cyhalothrin, 0.25L/ha	15.67 a	15.67 a	15.67 a	97.30 a	96.48 a	96.89 a	83.00 c	83.67 d	83.34 c
Control	15.33 a	16.00 a	15.67 a	98.10 a	97.93 a	98.02 a	94.67 a	95.00 a	94.84 a
CV %	4.90	4.70	4.80	0.70	1.50	1.10	0.80	2.30	1.55

Means with the same letter in a colum are not significantly different at 5 % (SNK) Test, DAT= Days After, Transplanting

Days to 50% Flowering

FARO 51 attained 50 % flowering earlier than FARO 37 in both 2016 and 2017 cropping seasons (Table 1). Also, rice plots that received combination of Lambda-cyhalothrin at rate of 0.38 L/ha + Carbofuran at rate of 3.75 kg/ha attained significantly (P<0.05) 50 % flowering earlier compared with attainment of 50 % flowering of rice in plots treated with combination of Lambda-cyhalothrin at rate of 0.38 L/ha + Carbofuran 2.5 kg/ha, and Carbofuran at rate of 3.75kg/ha+ Lambda-cyhalothrin at rate of 0.25 L /ha. Rice plots treated with Carbofuran at rate of 7.5kg/ha and the control plots attained 50 % flowering later than all rates of insecticide combinations evaluated in both 2016 and 2017 cropping seasons.

Gall midge incidence

Table 2 Show percentage incidence of gall midge at 21, 42 and 63 DAT, among the two variety and rates of insecticides evaluated in 2016 and 2017 cropping seasons (Table 2). FARO 51 had Significantly (P<0.05) lower percentage incidence of gall midge at 21, 42, and 63 DATcompared with percentage incidence of gall midge seen in plots planted with FARO 37. Rice plots applied with combination of Lambda-cyhalothrin at rate of 0.38L/ha + Carbofuran 3.75kg/ha had lowest percentage incidence of Gall midge at 21, 42, and 63 DATwhile Control (plots without any insecticide application) had the highest incidence of gall midge in both 2016 and 2017 cropping seasons (Table 2).

Table 2: Gall midge incidence at 21, 42, and 63 DAT as influence by Lambda-cyhalothrin + Carbofuran combined Application

Treatments	Incident 21		Incident 42		Incident 63		Means
	2016	2017	2016	2017	2016	2017	
Variety							
FARO **37**	4.41a	4.24a	4.08a	3.99a	4.48a	4.49a	4.28ab
FARO **51**	2.05b	2.03b	2.12b	2.13b	2.57b	2.29b	2.20
Insecticide Application							
Lambda-cyhalothrin, 0.75L/ha	2.70b	2.55b	2.23bc	2.33b	2.20bc	2.20b	2.37b
Carbofuran, 7.5 kg/ha	2.60b	2.58b	2.87b	2.83b	2.50b	2.50b	2.65b
Lambda-cyhalothrin,0.38L/h+Carbofuran3.75kg/ha	1.45c	1.42c	1.42c	1.25c	1.38c	1.35c	1.38c
Lambda-cyhalothrin,0.38L/h+ Carbofuran 2.5kg/ha	2.70b	2.62b	2.17bc	2.12b	2.83b	2.87b	2.55b
Carbofuran3.75kg/h+ Lambda-cyhalothrin, 0.25L/ha	2.42b	2.37b	2.77b	2.88b	2.93b	2.93b	2.72b
Control	7.50a	7.28a	7.13a	6.97a	9.28a	8.48a	7.77a
CV %	10.2	10.7	12.5	14.3	14.7	16.0	13.07

Means with the same letter in a colum are not significantly different at 5% (SNK) Test, DAT= Days After, Transplanting

Gall Midge Severity

In both 2016 and 2017 cropping seasons, FARO 51 had Significantly (P<0.05) lower percentage severity of Gall midge at 21, 42, and 63 DATcompared with percentage severity of gall midge present in plots planted with FARO 37 (Table 3). There was also Significant (P<0.05) variation in percentage severity of Gall midge among various rates of insecticide application. Rice plots applied with combination of Lambda-cyhalothrin at rate of 0.38L/ha + Carbofuran 3.75kg/ha, Carbofuran, 7.5 kg/ha and Lambda-cyhalothrin at rate of 0.751L/ha, had lowest percentage severity of Gall midge at 21DAT, while at 42 and 63 DAT only rice plots treated with combination of Lambda-cyhalothrin at rate of 0.38L/ha + Carbofuran 3.75kg/ha had Significantly (P<0.05) lower percentage severity of Gall midgecompared with percentage severity of gall midge in plots applied with Lambda-cyhalothrin at rate of 0.75L/ha, Carbofuran at rate of 7.5kg/ha and combination of Lambda-cyhalothrin at rate of 0.38L/ha+ Carbofuran 2.5kg/ha, Lambda-cyhalothrin,0.38L/ha+ Carbofuran 2.5kg/ha. Control (plots without any insecticide application) had the highest severity of gall midge in both 2016 and 2017 cropping seasons (Table 3).

Table 3: Gall Midge Severity at 21, 42, and 63 DAT as influenced by Lambda-cyhalothrin + Carbofuran combined Application

Treatments	Severity 21		Severity 42		Severity 63		
	2016	2017	2016	2017	2016	2017	**means**
Variety(V)							
FARO **37**	3.79a	3.86a	4.70a	4.53a	5.23a	4.82a	4.49a
FARO **51**	2.48b	2.27b	2.30b	2.00b	3.50b	3.07b	2.60b
Insecticide Application(I)							
Lambda-cyhalothrin, 0.75L/ha	1.97bc	2.05b	2.63b	2.58b	3.88b	3.53b	2.77b
Carbofuran, 7.5 kg/ha	2.32bc	2.68b	3.20b	3.10b	4.43b	3.75b	3.25b
Lambda-cyhalothrin,0.38L/h+Carbofuran3.75kg/ha	1.33c	1.45c	1.47c	1.47c	1.57c	1.45c	1.46c
Lambda-cyhalothrin,0.38L/h+ Carbofuran 2.5kg/ha	2.70b	2.82b	2.82b	2.82b	3.87b	3.67b	3.12b
Carbofuran3.75kg/h+ Lambda-cyhalothrin, 0.25L/ha	2.88b	3.05b	2.92b	2.85b	4.43b	4.22b	3.39b
Control	7.63a	6.33a	7.98a	6.78a	8.00a	7.03a	7.29a
CV%	12.21	7.52	8.30	10.89	11.94	11.13	10.32

Means with the same letter in a colum are not significantly different at 5% (SNK) Test, DAT= Days After, Transplanting

Gall midge parasitism

There was no significant (P>0.05) difference in percentage parasitism of gall midge between the two varieties evaluated, however, there was significant (P<0.05) difference in percentage parasitism of gall midge among rates of insecticides applied. At 21, 42 and 63 DAT rice plots treated with Carbofuran 3.75kg/ha + Lambda-cyhalothrin, 0.25L/ha and the control plot had highest gall midge percentage parasitism in 2016 and 2017 cropping seasons while the lowest percentage gall midge parasitism was found in plots applied with Lambda-cyhalothrin at rate of 0.75L/ha and Carbofuran 7.5kg/ha.

Table 4: Gall midge parasitism at 21, 42, and 63 DAT as influenced by Lambda-cyhalothrin + Carbofuran combined Application

Treatments	Parasitism21		Parasitism42		Parasitism 63		Means
	2016	2017	2016	2017	2016	2017	
Variety							
FARO **37**	0.33a	0.44a	0.89a	1.00a	1.00a	1.11a	0.80a
FARO **51**	0.44a	0.47a	0.72a	0.78a	1.11a	1.17a	0.78a
Insecticide Application							
Lambda-cyhalothrin 0.75L/ha	0.00a	0.00a	0.00b	0.16b	0.00c	0.33b	0.08b
Carbofuran 7.5 kg/ha	0.17a	0.33a	0.17b	0.33b	0.17c	0.38b	0.26b
Lambda-cyhalothrin 0.38L/ha+Carbofuran3.75kg/ha	0.33a	0.50a	0.33b	0.33b	0.33bc	0.44b	0.38b
Lambda-cyhalothrin 0.38L/ha+ Carbofuran 2.5kg/ha	0.33a	0.34a	0.50b	0.67b	0.83b	0.61b	0.55b
Carbofuran 3.75kg/h+ Lambda-cyhalothrin 0.25L/ha	0.67a	0.67a	2.00a	2.02a	2.67a	1.67a	1.62a
Control	0.83a	0.85a	1.83a	1.83a	2.33a	1.66a	1.56a
CV %	89.9	55.4	80.3	71.7	48.2	49.0	65.75

Means with the same letter in a colum are not significantly different at 5% (SNK) Test, DAT= Days After, Transplanting

Panicle per meter square

There was significant (P<0.05) difference in panicles per meter square among the two variety tested. FARO 51 had significantly (P<0.05) higher panicle per meter square compared to panicle per meter square of FARO 37. Whereas, the highest panicle of rice per meter square was gotten in plots applied with combination of Lambda-cyhalothrin 0.38L/ ha+Carbofuran 3.75kg/ ha.

Grains per Panicle

There was no significant (P>0.05) difference in grains per panicles among the two varieties tested and also among the various rates of insecticide applications (Table 5).

Grain Yield

There was significant (P<0.05) difference in grain yield between the two varieties tested. FARO 51 had significantly (P<0.05) higher grain yield compared to grain yield of FARO 37. Also rice grain yield was significantly (P<0.05) higher in plots treated with combination of Lambda-cyhalothrin at rate of 0.38 L/ha + Carbofuran 3.75 kg/ha compared to rice grain yield in plots treated with Lambda-cyhalothrin at rate of 0.75L/ha, Carbofuran at rate of 7.5kg/ha, Lambda-cyhalothrin 0.38L/ha + Carbofuran 2.5 kg/ha, Carbofuran 3.75 kg/ha + Lambda-cyhalothrin 0.25L/ha and Control plot (Table 5).

Table 5: Panicle/m^2, Grains/panicle and grain yield as influenced Lambda-cyhalothrin + Carbofuran combined Application.

Treatments	Panicle/ m^2			Grains /panicle			Grain yield kg/ha		
	2016	2017	**Mean**	2016	2017	**Mean**	2016	2017	**Mean**
Variety									
FARO **37**	267.39b	268.83b	268.11b	289.33a	294.33a	291.83a	2727.82b	2735.32b	2731.57b
FARO **51**	297.72a	298.39a	298.05a	285.50a	292.50a	289.00a	3040.19a	3082.93a	3082.93a
Insecticide Application									
Lambda-cyhalothrin 0.75L/ha	270.00b	272.17b	271.085	286.03a	296.33a	291.18a	2.959.43b	3051.27a	3051.27a
Carbofuran 7.5 kg/ha	276.17b	276.50b	276.335	284.50a	296.50a	290.50a	3015.08b	3020.83a	3017.96a
Lambda-cyhalothrin 0.38L/h+Carbofuran3.75kg/ha	324.00a	324.67a	324.335	284.67a	294.67a	289.67a	3187.05a	3181.77a	3184.41a
Lambda-cyhalothrin 0.38L/h+ Carbofuran 2.5kg/ha	278.00b	279.67b	278.835	286.10a	286.00a	286.05a	2750.87c	2773.93b	2762.40b
Carbofuran3.75kg/h+ Lambda-cyhalothrin 0.25L/ha	276.67b	277.00b	276.835	2.83.55a	293.50a	293.56a	2706.40c	2727.87b	2717.14b
Control	270.50b	271.67b	271.085	281.20a	293.50a	287.35a	2685.18c	2699.07b	2692.13b
CV %	4.51	8.53	6.53	3.92	3.91	3.93	2.90	23.20	13.05

Means with the same letter in a colum are not significantly different at 5 % (SNK) Test, DAT= Days After, Transplanting

DISCUSSION

Variations observed in tillering capacity between the two varieties evaluated (FARO 37 and FARO 51) may be attributed to their inherent trait because according to earlier Agronomic characteristics attributed to these varieties by Maji (2015) FARO51 have tillering capacity of between 10-15 while FARO37 can tiller between15-20. This suggest that the significant difference in tiller count among the two variety is due to inherent trait, not as a result of influence of different insecticide applications. Lower percentage incidence and severity of Gall midgeinRice plots applied with combination of insecticides compared with percentage incidence and severity of Gall midgeinRice plots applied with single application of insecticides Lambdacyaholotrin at rate of 0.75L/ha and Carbofuran at rate of 7.5kg/ha prove synergism of combined insecticide effect on management of gall midge in rice fields. The delay in attainment of 50% flowering observed in susceptible variety FARO 37 may be as a result of higher incidence and severity of African rice gall midge on those plots as it is earlier established by (Nwilene *et al.,* 2006) that any tiller attacked by African rice gall midge neither flower nor produce panicle. From this trend of incidence and severity of African rice gall midge (*Orseolia. Oryzivora)* infestation on rice it shows that FARO51 is a resistant variety. This confirms earlier finding of (Wada *et. al.* 2012) that rank FARO51 as moderately resistant variety to African rice gall midge (*Orseolia. oryzivora).* Parasitism of Africa rice gall midge by parasitoids was very low in both 2016 and 2017 cropping seasons thus, significant effect of their presence was not felt on population of Africa rice gall midge. However, gall midge parasitism at 21, 42 and 63 DAT was more in plots applied with lowest rates of insecticide combinations and the controlled plots, this is indicating that application of reduced rates of insecticide has less effect on parasitoids that help in checking the population of pest organisms. This is in line with earlier finding of (Nacro and Nenon, 2009) who stated that the use of insecticides to control AFRGM pose risk to human health and cause destruction of natural AFRGM enemies (in the case of foliar sprays). It is also noted that the parasitism of Africa rice gall midge was more at later stage of rice growth at 61 DAT suggesting that the larger population of parasitoid usually build up at advance stage of rice and thus their effect in checking pest organisms (Africa rice gall midge) is not much felt, as the percentage parasitism did not significantly correlate with panicle per meter square and grain yield. This, confirm earlier work of (Ogah *et al* 2010) who established that *platygasterdiplosisae* is an indigenous and gregarious egg-larval endoparasitoid of Afrgm. it lays its eggs within the gall midge eggs or neonate larva on plant surfaces, the adults then emerge from the fully-grown corpse of the gall midge larva, it can parasitize up to 80% of galls on rice plants, but mostly towards the end of the wet season and so fails to prevent economic damage. It was observed that there was no correlation between gall midge parasitism and grain yield, this may be due to fact that percentage parasitism of Africa rice gall midge was not high enough to effect much control on larva and eggs of gall midge.

References

Africa Rice Center (WARDA)/FAO/SAA,(2008).*N*ERICA®; the New Rice for Africa-compendium. Somado, E.A., Guei, R.G. and Keya, S.O. (Eds). Cotonou, Benin: Africa Rice Center (WARDA); Rome, Italy: FAO; Tokyo,Japan: Sasakawa Africaassociation. 2210pp.

Akinbile, C.O., Sangolgoyin, A.Y., Akintayo, I. Nwilene, F.E. and Futakuchi, K. (2007). Growthand yield responses of upland NERICA 2 under different water regimes in Ibadan,Nigeria. *Research Journal of Agronomy* 1(2):71- 75.

Balasubramanian, V., Sie, M., Hijmans, R.J. and Otsuka, K. (2007). Increasing rice production in Sub-Saharan Africa: challenges and opportunities. *Advances in Agronomy* 94:55-103.

Coyne, D.L., Sahrawat, K.L. and Plowright, R.A. (2004). The influence of mineral fertilizer application and plant nutrition on plant-parasitic nematodes in dry land and wetland rice in Côte d'Ivoire and its implications in long-term agricultural research trials. *Experimental Agriculture* 40:245-256.

F.A.O. (2000). FAO Rice Information 3: p2

Harris, K.M., Williams, C.T. Okhidievbie, O.,Lasalle, J. and Polasek, A. (1999). Description of a new species of *Orseolia* (Diptera: Cecidomyiidae) from Paspalum in West Africa, with notes on its parasitoids, ecology and relevance to natural biological control of the African rice gall midge, *O. oryzivora*. *Bulletin of Entomological Research* 89:441-448

Heinrichs, E.A. and Barrion, A.T. (2004). Rice feeding insects and selected natural enemies in West Africa, Biology, ecology identification. Hettel, G. P. (Ed.). International Rice research Institute. 237pp

Hossain, M. (2006). Rice in Africa: Can rice help reduce hunger and poverty in Sub-Saharan Africa? *Rice Today* 5: 41.

Imolehin E. D. and Wada A.C (2000). Meeting the Rice Production and Consumption Demand of Nigeria with improved Technologies. National Cereal Res Inst, Badaggi, Niger State, Nigeria, 1-11

International Rice Research Institute (IRRI),(2002). Standsard Evaluation System for Rice, International Rice Research Institute. Los Banos, Philippines. 71pp

Linares O. F. (2002). African rice (Oryza glaberrima) history and future potential, proceeding of *National Academy of science of the United State of American* 99; 16369-16365.

Maji, A.T (2015).Genetics of resistance to African rice gall midge in *Oryza glaberrima* Steud and molecular tagging studies of the resistance genes. *Phd Thesis*. Department of Agronomy, University of Ibadan, Nigeria. pp 54-58

Nacro, S. and Nénon, J. P. (2009). Comparative study of the morphology of the ovipositor of *Platygaster diplosisae* (Hymenoptera: Platygasteridae) and *Aprostocetus procerae* (Hymenoptera: Eulophidae) two parasitoids associated with the African rice gall midge, *Orseolia oryzivora* (Diptera: Cecidomyiidae). *Psyche* 2009:1-7

Nacro, S.D. (1994). Analysis of the tritrophique system of Cecidomyiidae of rice and its parasitoids in Burkina Faso, Ph.D. Thesis, University of Rennes, France, p. 243.

Nwilene, F.E., Nwanze, K.F. and Okhidievbie, O. (2006). African Rice Gall Midge: Biology, Ecology and Control—Field Guide and Technical Manual. Africa Rice Center (WARDA), Cotonou, Benin. 24 pp.

Ogah, E. O., Echezona, B.C. and Umeh, E. D. N. (2005). Effects of N-fertilisation and spacing on Africa rice gall midge, *Orseolia oryzivora* Incidence of African rice gall midge and its parasitoid 147 Harris and Gagne in a Sub-Humid area of Southeastern Nigeria. *Agro-Science* 4 (2):15-18.

Ogah, E. O., Nwilene, F. E. Ukwungwu, M. N., Omoloye, A. A. and Agunbiade, T. A. (2009). Population dynamics of the African rice gall midge *O. oryzivora* Harris and Gagne (Dipt:Cecidomyiidae) and its parasitoids in the forest and southern Guinea savanna zones of Nigeria. *International Journal of Tropical Insect Science* 29(2):86- 92.

Ogah, E. O., Odebiyi, J. A., Ewete, F. K., Omoloye, A. A. and Nwilene, F. E. (2010). Biology of the African rice gall midge Orseolia oryzivora (Diptera: Cecidomyiidae) and its incidence on wet-season rice in Nigeria, International Journal of Tropical Insect Science 30 32-39.

Rice Farmers' Association of Nigeria (RIFAN) (2017) Rice production in Nigeria increases to 5.8m tones. RIFAN Annual Report 2017.

SAS, (2003). SAS systems for Windows. Version 9.1 Edition. SAS Institute Inc. Cary, NC, USA.

Udemezue J.C. (2014). Adoption of FARO- 44 Rice production and Processing Technology by farmers in Anambra State. Post Graduat thesis, Department of Agricultural Extension University of Nigeria, Nsukka 1-55.

Wada A.C, Bakare S.O, Mohammed M., and Ukwungwu M.N (2012). Integrated management of African rice gall midge (AfRGM) *(Orseolia oryzivora,* Harris and Gagné), weeds and diseases of lowland rice. Agricultural SciencesVol.3, No.4, 486-490 (2012)