JEAS

Journal of Engineering and Applied Sciences 5 (2009)

JOURNAL OF ENGINEERING

AND

The challenge of African rice gall midge to rice production in the omasi rice ecosystem Anambra state Nigeria

I.C.E. Umeghalu, D.O. Amaefule

Department of Agricultural and Bioresources Engineering, Nnamdi Azikiwe University, Awka

Abstract

The challenge of the African Rice Gall Midge to rice production in the Omasi Rice Ecosystem was the interest of the researchers. Study was made of the reproductive life cycle and ecology of the midge. The conditions and practices that favour its survival and spread were noted. Experimental upland and irrigated rice plots were mono-cropped continuously for five years. Different pest control measures were adopted in an Integrated Pest Management fashion. The upland experimental farms gave improved paddy yield: 3.5-5.4 ton/ha in comparison to the 1-2.5 ton/ha prevalent in the ecosystem's farmers' upland plots. The irrigated experimental plots equally yielded 4.9-6.3 ton/ha of rice paddy. The farmers' prevalent yield for the irrigated plots was at an average of 3.5 ton/ha. The experiment further established that good upland rice yield is possible from the Omasi Rice Ecosystem if modern and scientific methods are adopted for cropping rice in the region.

Keywords: African rice gall midge; integrated pest management; rice paddy yield; ecology

1. Introduction

To keep pace with the increasing human population, the International Rice Research Institute (IRRI) projected that the 1989 global 500 million metric tones rice production will need increases of 20% and 65% by the years 2000 and 2020 respectively (IRRI, 1994). Such targets will only be a mirage if practical and sustainable strategies aimed at preventing or controlling insect pests of rice are not developed and popularized among rice farmers. These attacks result perennially to crop losses which in some cases may be as high as 100%. (Breniere, 1983).

Studies that can help in curtailing the attack of major insect pests of rice will thus be a bold step in the right direction of ensuring adequate rice production.

African Rice Gall Midge *Oreseolia Oryzivora* AfRGM is an important insect pest of irrigated and up land rice which has become well established in Nigeria and some other rice producing regions of Africa.

The species is morphologically distinct from Asian species *Oreseolia Oryzae* and is spreading to other rice growing areas.

The warm and humid environment of Omasi (in Aghamelum Local Government Area of Anambra State of Nigeria) rice ecosystem is conducive to the multiplication of the pest.

Cultural, biological, host plant resistance and chemical control methods are some of the pests control measures. Integrated Pest Management (IPM) combines the advantages of various control methods to achieve environmentally friendly pest control (Youndeowei, 2004).

Omasi is located at Aghamelum Local Government Area of Anambra State of Nigeria and has more than half a million hectares of rice field. About 65% of it is suitable for upland rice cultivation while the remaining 35% is enclosed within the Adarice Irrigated Rice Scheme (formerly Uzouwani Rice Farm Settlement), Lower Anambra River Basin at Omor. The ecosystem extends to Ifite Ogwari, Umueje and Umumbo. Over 250,000 hectares are planted under slash and burn culture which represents about 50% of the zones rice production.

2. Materials and methods

The study area is Omasi Rice Ecosystem. For five years (1994-1999), farmers in the zone were studied and interviewed. Experimental farms were maintained at Adarice Irrigated Rice Field, Omasi, Lower Anambra River Basin Development Authority, Omor, and an upland rice field at Umueje.

2.1. Cropping / farming practices in the studied area

The forest is manually cleared during the dry season period. Farmers slash, brush and fell trees during clearing. The time spent on land clearing depends on number of trees and average tree diameter (Nwuba, 1979). Virgin forests required more time to clear. Brush and trees are left to dry before burning. Logs left after the first burn are piled for a second burning. On virgin forest land, farmers usually grew rice crop for two consecutive years followed by maize or cassava cultivation before reverting to rice production on the same plot. As few soils in the area were sufficiently fertile for two years of consecutive rice farming, some farmers leave their land fallow for average of three years after cropping. With the onset of the wet season, rice was planted in April and may be continued till July or early August. Most popular cultivars planted were FARO 29, FARO 36, FARO 51 and IRR 1416.

Seeds were planted in hills: 25-40cm apart using a dribble stick or short-tip pointed knife at 6 seeds per hill average seeding rate. Virgin forest lands were usually cropped without fertilizer. Insecticides were sprayed for control of rice pests. About 45% of the farmers applied herbicides for weed control while the rest used knife for wedding the farm. Rice was harvested panicle-wise with hand knife or sickle and threshing done by beating a sizeable heap with stick. Winnowing of the threshed paddy was accomplished manually under natural air current (wind). Absence of motorable roads made usage of rice threshers impossible as it was difficult to transport them to farm locations (Adarice and Lower Anambra River Basin Development Authority plots were exceptions).

2.2. Farmers' paddy yield

Yield averaged 1 – 2.5 t/ha. The highest yield ever claimed was 3.2 t/ha. All farmers indicated that AfRGM attack was their major constraint followed by weeds and lack of fertilizer. Between 1991 – 1996, many farmers; especially those that secured agricultural loans from banks committed suicide due to serious crop failures African Rice Gall Midge attack was a major cause of these crop failures.

2.3. The African rice gall midge (AfRGM)

The pest AfRGM is a bud-boring diptera of the *Cecidomyiidae* family, a serious insect pest of rain-fed and irrigated low land rice in West Africa (Nwilene et al, 2003). It attacks rice only at the vegetative growth stage. The adult midge is tiny about 5mm long and resembles mosquito. The female is bigger with robоust orange coloured abdomen while the male is smaller with slender browm abdomen and longer antennae (Breniere, 1983) It is nocturnal and phototropic.

2.4. Life cycle

Life cycle from egg laying to the emergence of the young midge from the gall takes between 26 to 36 days; about 2 to 3 generations of the midge is possible during one cropping season. (Umeh et al, 1995)
The adult midge lives for about 2 to 5 days during which the female lays between 100 to 400 eggs within 2 to 3 days of emergence. The eggs are hatched within 2 to 3 days into maggots or larvae. These larvae creep down between the leaf sheet and culms into the bud of vegetative tillers of growing rice plant where larval feeding takes place (Breniere, 1983).
The larval activity in the bud causes the bud to increase in size thus developing a cavity within which the young larva is housed till pupation. The feeding larva secrets an enzyme called C*ecidogen* which helps to destroy the bud, induces the plant cells to proliferate. The attacked leaf sheet elongates further, forming a tube-like leaf structure called a gall; known also as the onion shoot or silver shoot. (Nwakpu, 2003).
The infested tiller neither initiates the formation of more leaves nor bear panicles. (Matsushima, 1976) (WARDA, 2005). At the end of pupation, the matured pupa moves out of the gall by wriggling upwards from its base to the top, with the aid of its dorsal spines. Through the hole cut by the pupa at the spongy tip of the gall, the adult insect protrudes head first out of the gall leaving the empty pupa case half-stuck in the hole at the tip of the gall. (Nwakpu, 2003).

2.5. Conditions that favoured the midge's development in the ecosystem

a. African Rice Gall Midge eggs and larvae thrive better under conditions of high relative humidity. This condition prevails in the ecosystem between September and early November. The farmers poor timing of planting led to the rice crop's vulnerable, early vegetative growth to fall within this period.
b. The unco-ordinated planting of rice in many of the small rice farm holdings within the locality favoured midge migration especially as lesser distances existed between rice farms.
c. The presence of ratoon, rice stubbles, volunteer rice and wild rice species in the farm lands offered habitat to the midge after harvest. From these, the midge returned

to the newly growing rice crops as soon as they were cropped: a vicious cycle indeed.
d. Heavy application of nitrogenous fertilizers induced continuous tillering of rice and this allowed the midge to infest continuously. Ogah et al (2005) corroborates this fact.
e. An un-kempt field provided alternative host plants to the midge, which encouraged continued build up of midge population even after rice crop harvest.

2.6. Control measures adopted to check the african rice gall migde

Different methods were adopted in the experimental plots to control the AfRGM.

2.6.1. Cultural method

Lines with shorter duration of between 90-130 days were planted to reduce the generation cycles for the AfRGM multiplication. Such varieties planted were OS6, faro 48 (ITA 301), FARO 46 (ITA 315)
* Tolerant rice varieties (eg FARO 51) were planted on which attack was moderate.
* The fields were planted early to enable the plants mature before the critical period of the insect pest build-up
* Nitrogenous fertilizer dosage was reduced to a maximum of 55kg/ha to avoid continuous tillering of rice crop. Studies by Ogah et al (2005) indicates an optimum of 70kg/ha. Close planting was employed to maximize plant population and more of potassium and phosphorus fertilizers were applied at the rate of 30kg/ha and 30kg/ha respectively. With small amount of nitrogenous fertilizer. This made the culm of the rice plant too strong for the midge to bore hole on.
* All rice farms around were cropped at the same period so that growth is uniform and access to alternative habitat was difficult for the midge.
* Room was not given to wild rice, ratoon, stubbles and weed in the experimental farm as very strict farm hygiene was practiced.
* During harvest the matured rice was cut at about 2-5cm above ground level, thus rice stubs that could have otherwise provided continued housing to the midge were removed and later burnt.
* The rice farm was ploughed up after harvest to destroy the rice stubbles, wild rice, volunteer rice and weeds which would have otherwise provided alternative habitat for the midge.

2.6.2. Chemical method

African Rice Gall Midge is an internal stem borer of rice and therefore inhabits inside the rice stem. This makes the usage of contact insecticidal formulations non-effective (Tonaka and Yoshida, 1975). Therefore systemic formulations were applied. In the irrigated rice paddies at Omor, Adani and Umumbo, Diazinon was used at dozes of 0.5% of active materials applied 4 times with a one week interval from the 10th day after transplanting in the irrigated plots, and the same doze in the upland plots in 4 applications from 25days after planting, these gave excellent results.
Contact insecticides where necessary were limited in their extent of application because they kill both the insect pest, and the predators and parasitoids of the insect pest.

3. Results and discussion

3.1. Yield from the experimental plots

Paddy yields from the (upland and irrigated) experimental farms are shown in Table 1 below. Yields of 5.0, 4.6, 3.8, 5.2, 4.8 ton/ha were obtained in the upland plots for the years 1995, 1996, 1997, 1998 and 1999 respectively. This yield, as can be seen in figure 1, supersedes clearly the 1-2.5 ton/ha obtained from the ecosystem's farmers upland rice plots. The irrigated plots equally gave yields of 6.2, 5.7, 4.9, 5.5, and 6.3 ton/ha for those corresponding years. These were far more than the farmers' average of 3.8 ton/ha.

Table 1
Annual paddy yield of the Experimental farms (1995-1999)

S/NO.	System of Cropping	Yield t/ha				
		1995	1996	1997	1998	1999
1.	Upland	5	4.6	3.8	5.2	4.8
2.	Irrigated	6.2	5.7	4.9	5.5	6.3

Further presentation of the paddy yield from the experimental farms is done in figure 1 below. Here, the 1-2.5 ton/ha yield prevalent in the ecosystem farmers' upland plots is also shown graphically.

3.2. The upland experimental farms

It is important to note the following:

The plots were consistently cropped for 5 years with yields of appreciable magnitude before leaving to follow.

In the years 1995, 1996, 1998 and 1999, the plots were planted up in April / May. This allowed good vegetative growth to be established prior to the critical period of midge build up in the ecosystem- July to September.

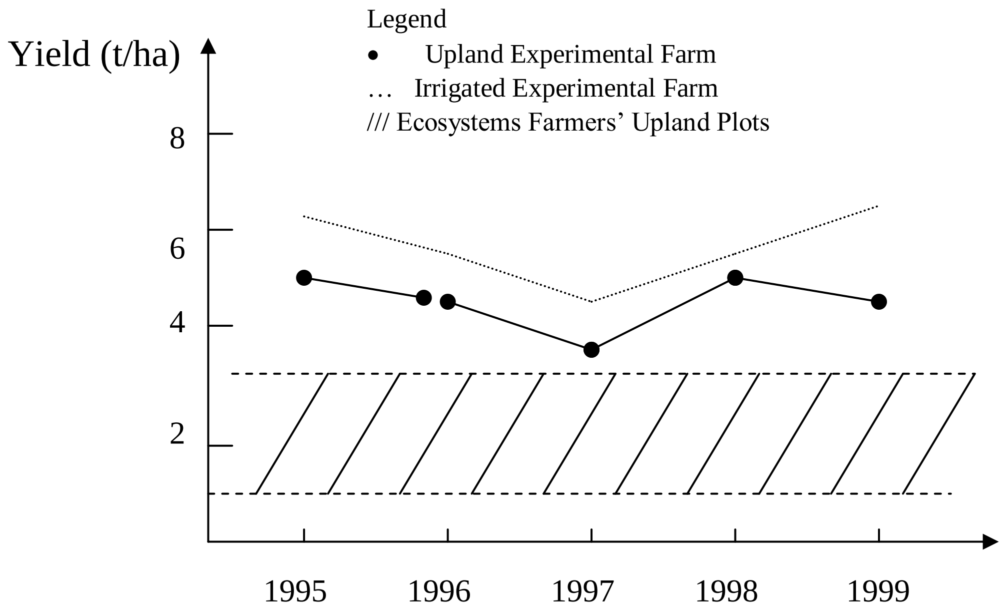

Fig. 1. Annual paddy yield of the experimental farms.

Planting was delayed in 1997 until mid May due to late sharing of rice plots to farmers by the River Basin Development Authority. To mitigate the vulnerability of the rice plant when its early growing period coincided with that of heavy midge infestation, phosphorus fertilizer was applied with limited quantity of Nitrogenous fertilizer. This measure in addition to the others adopted, intercepted the enormous yield reduction that would have resulted at 3.8 ton/ha.

The yield decline at the 3rd year of cropping showed the inadequacy of the soils' nitrogen content. With the earlier planting dates of the 4th and 5th years, proper dose of nitrogenous fertilizer (55kg/ha) was applied, correcting the Nitrogen deficiency of the plots. A more encouraging yield (5.2 and 4.8. ton/ha) was realized thereby.

3.3. The irrigated experimental farms

The 5 years experiments in the irrigated plots of at Adarice and Lower Anambra River Basin could have realized in some of the years more yield than was shown in Table 1. This was even so bad that the 1998 yield from these plots averaged 5.5 ton/ha as against 5.2 ton/ha obtained from the upland plots.

This can be attributed to the following reasons:

Regular sharing of the plots were done late and without sequence

Pumping of water into the canals for use in the farms were at the leisure of the project officers who gave sundry reasons like pump failure, unavailability of diesel, etc for their non performance.

However, if the modern method of rice cropping is properly applied, increased rice yield is possible.

4. Conclusion and recommendations

The attack of the AfRGM to growing rice and the consequent paddy yield losses deserve adequate co-ordinated attention from farmers, researchers and policy makers. A well-designed Integrated Pest Management (IPM) approach has been demonstrated to substantially check the cataclysmic outcome of unhindered midge infestation on paddy yield. This experiment has further established that good upland rice yield is possible from the Omasi Rice Ecosystem if modern and scientific methods are adopted for cropping rice in the region. Adopting these findings can lead to increased local rain-fed rice output. Properly implemented irrigated rice farming will also further boost local rice production. The researchers advocate its demonstration through the adoption of IPM approach under reliable irrigation practice. Employing pest resistant rice varieties (with superior agronomic and grain yield characteristics) as has been achieved with the Asia Rice Gall Midge (Nwilene et al, 2003) is also advocated.

Commitment to these and other necessary rice researches, post-harvest processes inclusive, and to the use of their results will doubtlessly reduce the heavy rice import and the food insecurity encountered in Nigeria presently.

Acknowledgement

The authors greatly appreciate the defunct Adar Rice Production Nig. Ltd. Adani Enugu State and the Lower Anambra River Basin where some of the experimental rice farms were maintained.

References

Breniere, J., 1983. The Principal Insect Pests of Rice in West Africa and their Control. West Africa Development Association. P.O Box 1019 Monrovia, Liberia.

IITA Annual Report, 1984. International Institute of Tropical Agriculture, Oyo Road, PMB 5320, Ibadan, Nigeria.

IITA Annual Report And Research Highlights, 1987/88. International Institute of Tropical Agriculture, PMB 5320, Oyo Road, Ibadan, Nigeria.

IRRI Rice Research Notes, 1994. Volume 19 No. 1 International Rice Research Institute, P.O. Box 933, Manila 1099, Philippines.

IRRI Reporter Special Issue, 1995. Fragile lives in fragile ecosystems. International Rice Research Conference, 1995. International Rice Research Institute, P.O. Box 933, Manila 1099, Philippines.

Matsushima, S., 1976. High Yielding Rice Cultivation University of Tokyo Press.

Nwakpu, C., 2003. Practical Guide to Lowland Rice Production in Nigeria. Snaap Press Ltd., Enugu, Nigeria.

Nwilene, et al, 2003. Host plant resistance and biological control of African Rice Gall Midge: Progress, Problems and future needs. In Bahan, J. et al Book of Abstracts of the Joint Conference on Integrated Pest and Vector Management (IPVM) in the Tropics: Perspective and Future Strategies, ICIPE, Nairobi, Kenya, 9-13 June, 2003.

Nwuba, E.I.U., 1979. Land clearing - A pre-requisite for self-sufficiency in Food. Proceedings, Nigerian Society of Agricultural Engineers, 3, 243 - 256.

Ogah, et al., 2005. Effects of N-fertilization and spacing on African Rice Gall Midge Orseolia Oryzivora Harris and Gagne in a sub-humid area of southeastern Nigeria. Agro-Science vol., 4, 2, 2005, pp. 15-18.

Tonaka, A., Yoshida, S., 1975. Nutritional Disorders of the Rice Plant in Asia International Rice Research Institute, Los Banos, Laguma, Philippians, Manila, Philippians.

Umeh, E.D.N., Joshi, R.C., Ukwungwu, M.N., 1995. Field Insect Pests of Rice in Africa. Binlogr, and Control IITA Research Guide 43, International Institute of Tropical Agriculture, Training Program, PMB 5320, Ibadan, Nigeria.

WARDA, 2005., WARDA IPM project 05: Integrated management of the African Rice Gall Midge (AfRGM)http:/www.spipm.cgiar.org/WARD%20IPM%20project%2005.htm.

Youndeowei, A., 2004a. Principles of Integrated Pest Management: Growing Healthy Crops. Ministry of Food and Agriculture (MOFA) Plant Protection and Regulatory Services Directorate (PPRSD). Ghana.

Youndewei, 2004b. Integrated Pest Management Practices for the Production of Cereals and Pulses. Ministry of Food and Agriculture (MOFA) Plant Protection and Regulatory Service Directorate (PPRSD) Ghana.