ORIGINAL RESEARCH REPORT NIGER. J. PLT. PROT. 37(2) 41-53 (2023)

CROP LOSS INDUCED BY AVIAN AND RODENT PEST INFESTATIONS IN A LOWLAND RICE (*Oryza sativa* L.) GROWN WITHIN SAVANNA TRANSITION ENVIRONMENT OF NIGERIA

[1*]Okwara, O. S., [1]Pitan O. R., [2]Osunsina I. O. O. and [1]Afolabi C. G.
[1]Department of Crop Protection, [2]Department of Forestry and Wildlife
Federal University of Agriculture, Abeokuta, Ogun State, Nigeria.
***Corresponding Author**: okwaraos@funaab.edu.ng

SUMMARY

Rice (*Oryza sativa* L.) belongs to the family poaceae and has become one of Nigeria staple food. Cultivation of this crop is been faced with the menace of vertebrate pests of which birds and rodents are the most implicated. This research, carried out at the Federal University of Agriculture, Abeokuta, Nigeria, during the 2020 and 2021 cropping seasons was to identify the bird and rodent pest species associated with lowland rice, determine their infestation status and quantify the losses induced. The experiment was a split-plot arrangement fitted into a Randomized Complete Block Design. Main plots were protection and no-protection, sub-plots were four rice varieties: Ofada, NERICA-L-34, ARICA-3, and WITA-4. Data collected were subjected to Analysis of Variance ($p \leq 0.05$) and means were compared using the Least Significant Difference (LSD). The bird pests identified were: Passeriformes - *Ploceus melanocephalus Linnaeus (Ploceidae), Ploceus cuculatus* Muller *(Ploceidae)* and *Spermestes cucullatus Swainson (Estrildidae) while the rodent pest identified was Thryonomys swinderialus* Fitzinger (Thryonomyidae). In 2020 and 2021, the infestation levels of birds and rodents were significantly higher under the no-protection (1.21 and 5.24) and (2.31 and 2.62) than the protected plots (0.00 and 0.56) and (0.00 and 0.18) respectively, the bird- and rodent-induced damages were also significantly higher under the no-protection plots. The estimated bird- and rodent-induced losses ranged between 85.59% - 92.01% and 83.44% - 95.98% in 2020 and 2021, respectively. In conclusion, bird and rodent pests cause significant loss to rice crops and therefore, protection measures are recommended for optimum grain yield.

KEYWORDS: Protection, No-Protection, Infestation, Rodent, Avian, Crop loss

Rice (*Oryza sativa* L.) (Poaceae) has become one of the most popular food crops globally making it relevant to achieving food security and national income (4). Although rice production is generally associated with the Asian continent (the world's largest producer), it is still a commodity of strategic importance to human and the most rapidly growing food source in Africa (13**).** It is widely grown across different agro-ecological zones ranging from the Sahel to the forest zones and is differentiated by the length of the growing season (14). In Nigeria, rice is cultivated in upland and swamp (lowland) ecosystems with the upland production accounting for about 30-35% of total rice production area in the country with a yield between 0.8-2.0 tonnes/ha, while the swamp production system accounts for about 25% with yield as high as 2 to 8 tonnes/ha (8). It has become a traditional staple food source in some parts of West Africa and it is increasingly becoming a significantly important food source in other parts of Africa particularly the Eastern Africa, Central Africa and the Southern Africa (2). It is a monocot with edible grains which is comprised mainly of carbohydrate, proteins and other essential vitamins as a sources of energy, minerals and vitamins for the global population (1). It serves as a major food source capable of cushioning the effect of under-nutrition and severe hunger among many households globally as it is commonly eaten in many localities when processed into different edible forms. It is an extremely versatile crop, which adapts to different conditions of soil and climate making it to be considered as the species with the greatest potential to fight hunger globally (7). There are many constraints to rice production which can however be either biotic or abiotic and seriously affect the growing potential of rice in Africa. These constraints are enormous and range from poor land and crop management to diseases and pests of which vertebrate pests are the major constituents (4).

Rodents as vertebrate pest of agricultural crops have been reported to have the ability to infest and consequently cause damage to crops in different agro-ecological zones globally. They have been known to cause major damage to agricultural crops in several parts of the world (12) and are currently recognized as pests in many agricultural systems in dire need of control. They have been considered as the second most important pest of farmers (after insects) of which the farmers have least control (18). In Southeast Asia for instance, there have been reported losses by rodents which amount to approximately 10% annually for rice crop (19), with over 50% yield loss experienced in some certain years of rodent outbreaks (3). Aves (birds) on the other hand, have been considered to be one of the important agricultural pests in both field and stored grain crops (6) and have been reported extensively to have caused considerable damage to field crops. They are rather specific vertebrate pest species that particularly feast on cereal crops with the capability to seasonally migrate over long distances, flock in great numbers and sometimes have a flexible diet of which agriculturally cultivated crops may only be a part (4). They infest rice crops which are also vulnerable to bird attacks at early crop establishment stages and highly susceptible from the milky stage up to maturation phase. This is probably one of the reasons why birds have been labeled as the second most important biotic constraint to rice production in Africa after weeds (9) and are responsible for more than 15% crop loss estimate of global rice production. The damage caused by pest notably birds, is one of the greatest challenges facing growers of a wide range of arable crops globally. However, the amount of crop losses induced and the consequent economic damage sustained is largely unquantified especially in most developing countries (3).

There is no country globally that has been adjudged to be free from the damage caused by these pests (birds and rodents) which have been implicated multiple times to have severe impact on several agricultural crops (17). Rodents as a reported notorious pest of agricultural crops have caused severe damages to various crops both directly and indirectly, they can adjust to the cropping system of the environment and even emigrate after crop harvest into another habitat so long as there is food availability which is necessary for their survival (16). De Mey, *et al. (5*) in his study reported that birds cause damage to cereal crops across Africa resulting in both monetary losses as well as food shortage. The research reported a 13 % to 26 % crop loss in Cameroon, 15 % crop loss in Senegal, about $0.7 million loss in Kenya (in monetary value) and a total of at least $15 million loss in eastern Africa. These losses are only but a few, among the several reported (documented and undocumented) losses across Africa (both monetary and food security-wise) by these pests (rodents and birds). This has made this research necessary with the aim to identify the bird and rodent pest species associated with lowland rice production, determine their infestation and damage levels and to quantify the crop loss induced on the crop.

MATERIALS AND METHODS

Study Area

This study was carried out at the inland valley region (FADAMA) of the Teaching and Research Farms, Federal University of Agriculture, Abeokuta (FUNAAB), Ogun State, Nigeria, under the forest-savannah transition agro-ecological zone during the 2020 and 2021 cropping seasons. The location is Latitude 7º, 20´ N and Longitude 3º 23´ E with a total annual rainfall ranging from 1005.00 mm to 1036.20 mm in 2020 and 2021 respectively and an average mean (maximum and minimum) temperature of 333.50 ºC and 335.35 ºC for 2020 and 2021 respectively. The research period was between April and November each year. Four (4) rice varieties; Ofada, NERICA L-34, ARICA-3 and WITA-4 were planted in two groups. One group had all four varieties planted with protection by providing barrier-nets to keep away the bird pests and cage traps for live capture of rodents with three replications. The Protection was such that each rice plot was mounted with bamboo stakes of about 5 meters above ground level on all four corners of the plot and a barrier-net with small mesh size was thrown and spread across these mounted bamboos covering all sides of the plot as well as the top. This was done to ensure that each rice plot was completely protected against the infestations from the avian pest. Along with the securely mounted barrier nets, cage traps were strategically placed on the field around this protected group of rice plots to provide protection against the rodent pest as this group of pest are capable of causing a tear or a break of the barrier net with their jaws as a result of their gnawing ability. The traps also doubled as a capture mechanism for the rodent pest and so they were constantly baited and re-baited at intervals. Another group of rice plots had all four rice varieties planted without protection and likewise with three replications.

This experiment was in a split-plot arrangement fitted into a Randomized Complete Block Design, replicated thrice. The main plots for this research were the two (2) groups (Protection and No-Protection groups) while the sub-plots were the four (4) rice varieties. The rice seeds were first pre-germinated by soaking in water for twenty - four (24) hours followed by a forty - eight (48) hour incubation period before being raised on nursery beds. The pre-germinated seeds were planted on the nursery beds using the broadcast method at a seed sowing rate of 100 kg ha^{-1} (i.e 0.04 kg per 4 m^2) after which the germinating seedlings were transplanted twenty – one (21) days later, into already prepared rice plots of size 4 m x 5 m (20 m^2) for each rice variety. A total of twenty – four (24) rice plots were prepared for this research. Twelve (12) plots were the Protection group while the other twelve (12) plots were the No-Protected group. A 2 - 3m spacing was maintained between the two groups. The rice plots were spaced with a 0.5 m bunds between each rice plot while a 1 m spacing was maintained between the replicates within each group. The sowing depth was 3 cm and the spacing between seedlings was 25 cm x 25 cm at 1 seedling per stand.

Assessment of Rodent and Bird damage of the rice crop

Direct field observations were adopted for the damage assessments of these pests (rodents and birds) and it commenced two weeks after the transplanting of the nursery seedlings. The data on infestation levels, percentage damage levels and the consequent crop losses induced by birds and rodents were collected. The infestation level of birds on the rice crops was done using the point count technique as demonstrated by Ralph *et al.,* 1995. For this research, a 5-minute point count was adopted for the infestation levels by birds and the data recorded fortnightly. The count was done by a field observer standing at a vantage position where the entire experimental plots could be viewed in a single glance. The observer ensured that there was no form of human activity (or a display of any form of activity) that could potentially interfere with (or influenced) the birds' activity (infestation) or scare the birds away from the field for the 5 minutes of the point count.

The infestation level of rodents was likewise recorded fortnightly using the quadrates techniques demonstrated by Sarwar, (17). A 1 m by 1 m quadrant was used to sample each rice plot in a diagonal pattern and the rice crop with damaged tillers as a result of rodent infestation were counted and expressed in percentages using the formula;

$$\text{Infestation level} = \frac{\text{The number of plant damaged tillers}}{\text{The total number of plant within quadrate}} \times 100$$

The damage levels that resulted from these infestations by both birds and rodents were recorded using a 5-point scale as shown below;

0 = No damage
1 = less than 10% damage to tillers or/and panicles
2 = between 10% and 50% damage to tillers or/and panicles
3 = between 50% and 90% damage to tillers or/and panicles
4 = Greater than 90% damage to the total destruction of the crop

Statistical Analysis

The data obtained were first subjected to data transformation using the square root model before analysis of variance (ANOVA) was carried out. GenStat statistical software package, twelfth (12th) Edition, version 12.1.0.338 was used and the treatment means were compared using the Least Significant Difference (LSD) at a probability level of 5%

RESULTS

In 2020 and 2021, the Group main effect (Protection and No-protection) on the infestation level of avian pests was significant, $F(1, 12) = 67.66$, $MSE = 0.043$, $p = 0.014$ and $F(1, 12) = 0.28$, $MSE = 0.029$, $p < 0.001$, respectively, the Variety effect was not significant, $F(3, 12) = 0.40$, $MSE = 0.029$, $p = 0.75$n.s and $F(3, 12) = 0.89$, $MSE = 0.405$, $p = 0.57$n.s, respectively, so also is the interaction of these two effects (Group and Variety) which was also not significant, $F(3, 12) = 2.70$, $MSE = 0.043$, $p = 0.09$n.s and $F(3, 12) = 0.78$, $MSE = 0.029$, $p = 0.53$n.s, respectively. Similarly, the Group main effect on rodent infestation level was significant, $F(1, 12) = 2.12$, $MSE = 0.097$, $p = 0.014$ and $F(1, 12) = 22.34$, $MSE = 0.405$, $p = 0.042$, respectively, the Variety effect was significant in 2020, $F(3, 12) = 3.52$, $MSE = 0.097$, $p = 0.04$, but not significant in 2021, $F(3, 12) = 0.89$, $MSE = 0.405$, $p = 0.47$n.s, while the interaction of these two effects was also not significant, $F(3, 12) = 1.55$, $MSE = 0.097$, $p = 0.25$n.s and $F(3, 12)$

= 0.45, MSE = 0.405, p = 0.72n.s, respectively for 2020 and 2021.

For damage that resulted from these infestations (table 2), the Group effect was significant in both 2020 and 2021; F(1, 12) = 18.00, MSE = 0.017, p = 0.041 and F(1, 12) = 16.10, MSE = 0.017, p = 0.047, respectively, the Variety effect was not significant, F(3, 12) = 1.43, MSE = 0.017, p = 0.28n.s and F(3, 12) = 0.70, MSE = 0.017, p = 0.57n.s, respectively, as was the interaction effect of these two factors which was also not significant, F(3, 12) = 2.44, MSE = 0.017, p = 0.12n.s and F(3, 12) = 0.28, MSE = 0.017, p = 0.84n.s, respectively for the avian pests. And similarly, the damage level that resulted from the rodents infestation showed the group effect as significant in both 2020 and 2021; F(1, 12) = 17.70, MSE = 0.005, p = 0.042 and F(1, 12) = 23.29, MSE = 0.405, p = 0.040, respectively, the variety effect was not significant, F(3, 12) = 2.25, MSE = 0.005, p = 0.52n.s and F(3, 12) = 0.33, MSE = 0.405, p = 0.80n.s, respectively, and the interaction effect was also not significant; F(3, 12) = 3.15, MSE = 0.005, p = 0.07n.s; and F(3, 12) = 0.91, MSE = 0.405, p = 0.46n.s respectively.

Table 1: Infestation levels of birds and rodents on four rice varieties grown under protection and no-protection field plots in 2020 and 2021 cropping seasons

	2020		2021	
Treatment	**Bird**	**Rodent**	**Bird**	**Rodent**
Group				
Protection	0.00 ± 0.09	0.56 ± 0.13	0.00 ± 0.03	0.18 ± 0.18
No-protection	1.21 ± 0.09	5.24 ± 0.13	2.31 ± 0.03	2.62 ± 0.18
LSD (0.05)	0.56*	0.80*	0.16*	1.09*
Variety				
Ofada	0.40 ± 0.08	2.79 ± 0.13	0.52 ± 0.07	1.88 ± 0.26
WITA-4	0.45 ± 0.08	1.80 ± 0.13	0.62 ± 0.07	1.02 ± 0.26
NERICA L-34	0.23 ± 0.08	1.66 ± 0.13	0.67 ± 0.07	0.76 ± 0.26
Arica-3	0.20 ± 0.08	3.13 ± 0.13	0.64 ± 0.07	0.71 ± 0.26
LSD (0.05)	0.26ns	0.39*	0.22ns	0.80ns
V X G				
LSD (0.05)	0.45ns	0.66ns	0.27ns	1.12ns

- ? * = Significant at 5% probability level (at $P \leq 0.05$)
- ns = Not Significant
- The LSD are for means along the same column

Table 2: Percentage damage levels induced by birds and rodents on four rice varieties grown under protection and no-protection field plots in 2020 and 2021 cropping seasons

	2020		2021	
Treatment	**Bird**	**Rodent**	**Bird**	**Rodent**
Group				
Protection	0.00 ± 0.05	0.06 ± 0.05	0.00 ± 0.06	0.02 ± 0.04
No-protection	0.10 ± 0.05	0.31 ± 0.05	0.15 ± 0.06	0.17 ± 0.04
LSD (0.05)	0.56*	0.80*	0.40*	1.06*
Variety				
Ofada	0.04 ± 0.05	0.20 ± 0.03	0.02 ± 0.05	0.10 ± 0.05
WITA-4	0.05 ± 0.05	0.13 ± 0.03	0.04 ± 0.05	0.08 ± 0.05
NERICA L-34	0.03 ± 0.05	0.14 ± 0.03	0.03 ± 0.05	0.06 ± 0.05
Arica-3	0.01 ± 0.05	0.18 ± 0.03	0.07 ± 0.05	0.06 ± 0.05
LSD (0.05)	0.16ns	0.09ns	0.17ns	0.16ns
V X G				
LSD (0.05)	0.26ns	0.30ns	0.31ns	0.23ns

? * = Significant at 5% probability level (at P≤0.05)
▪ ns = Not Significant
The LSD are for means along the same column

The grain yield (kg) obtained in this research in 2020 and 2021 seasons showed the group effect was significant; F(1, 12) = 159.59, MSE = 461.4, p = 0.006 and F(1, 12) = 141.18, MSE = 1034.0, p = 0.007, respectively, with a higher yield obtained in the protected group than the no-protection group, whereas the variety effect on the grain yield was not significant, F(3, 12) = 0.28, MSE = 461.4, p = 0.838n.s and F(3, 12) = 0.37, MSE = 1034.0, p = 0.778n.s, respectively, and likewise the interaction effect was also not significant; F(3, 12) = 1.46, MSE = 461.4, p = 0.275n.s and F(3, 12) = 0.82, MSE = 1034.0, p = 0.508n.s, respectively. In similar manner, the group effect on the panicle weight in 2020 and 2021 was significant; F(1, 12) = 3.41, MSE = 0.100, p = 0.003 and F(1, 12) = 3.01, MSE = 0.152, p = 0.004, respectively, the variety effect showed no statistical significance; F(3, 12) = 1.92, MSE = 0.100, p = 0.18n.s and F(3, 12) = 0.51, MSE = 0.152, p = 0.68ns, respectively, as well as the interaction effect also was not significant; F(3, 12) = 0.16, MSE = 0.100, p = 0.924n.s and F(3, 12) = 0.94, MSE = 0.152, p = 0.45n.s, respectively.

The estimated percentage grain yield (kg) and panicle weight (g) losses experienced (table 4) in 2020 cropping season were; 91.19 %, 91.45 %, 85.59 %, 92.01 % and 89.16 % 89.39 %, 85.31 %, 97.36% for Ofada, WITA-4, NERICA L-34 and Arica-3, respectively, and in 2021, the grain yield loss recorded was; 95.98%, 90.46%, 83.44% and 93.55% while the estimated panicle weight loss was; 92.26%, 86.64%, 88.87% and 93.03% for Ofada, WITA-4, NERICA L-34 and Arica-3, respectively.

Table 3: Yield obtained from four rice varieties grown under protection and no-protection field plots in 2020 and 2021 cropping seasons

	2020				2021			
	1000 Grain Weight (g)	Number of grain per panicle	Panicle Weight (g)	Grain yield per plot (kg)	1000 Grain Weight (g)	Number of grain per panicle	Panicle Weight (g)	Grain yield per plot (kg)
Group								
Protection	21.38 ± 0.19	183.20 ± 6.51	4.62 ± 0.24	160.90 ± 11.71	21.96 ± 0.25	189.80 ± 8.98	4.58 ± 0.28	186.70 ± 14.32
no-protection	0.00 ± 0.19	0.00 ± 6.51	0.44 ± 0.24	12.90 ± 11.71	0.00 ± 0.25	0.00 ± 8.98	0.45 ± 0.28	16.50 ± 14.32
LSD (0.05)	1.13*	28.03*	1.03*	50.40*	1.10*	38.64*	1.19*	61.61*
Variety								
Ofada	10.65 ± 0.24	99.20 ± 10.35	2.59 ± 0.18	89.70 ± 12.40	11.15 ± 0.15	115.20 ± 10.68	2.57 ± 0.23	97.00 ± 18.57
WITA-4	10.63 ± 0.24	84.00 ± 10.35	2.61 ± 0.18	89.40 ± 12.40	10.64 ± 0.15	80.70 ± 10.68	2.44 ± 0.23	112.10 ± 18.57
NERICA L-34	10.85 ± 0.24	83.50 ± 10.35	2.66 ± 0.18	80.00 ± 12.40	11.16 ± 0.15	87.80 ± 10.68	2.64 ± 0.23	94.10 ± 18.57
Arica – 3	10.63 ± 0.24	99.80 ± 10.35	2.67 ± 0.18	88.50 ± 12.40	10.96 ± 0.15	95.80 ± 10.68	2.40 ± 0.23	103.20 ± 18.57
LSD (0.05)	0.74ns	22.54ns	0.40ns	27.02ns	0.34*	32.91ns	0.49ns	40.45ns
V X G								
LSD (0.05)	1.08ns	30.66ns	0.80ns	42.87ns	0.84*	44.18ns	0.93ns	58.53ns

- The LSD are for means along the same column
- ns =Not Significant
- Prot. = Protection
- No-Prot. = No Protection

* = Significant at 5% probability level (at $P \leq 0.05$)

Table 4: Estimated crop loss induced by birds and rodents on the yield parameters of the four rice varieties grown in 2020 and 2021 cropping season

	2020						2021					
	Grain yield / plot(kg)			Panicle weight (g)			Grain yield / plot(kg)			Panicle weight (g)		
Variety	Prot.	No-prot.	Loss (%)	Prot.	No-prot.	Loss (%)	Prot.	No-prot.	Loss (%)	Prot.	No-prot.	Loss (%)
Ofada	10.56(1.58)	0.93(0.17)	91.19	4.89(0.34)	0.53(0.22)	89.16	11.94(2.34)	0.48(0.42)	95.98	4.78(0.39)	0.37(0.23)	92.26
WITA 4	10.55(1.58)	0.90(0.17)	91.45	4.62(0.34)	0.49(0.22)	89.39	13.10(2.34)	1.25(0.42)	90.46	4.49(0.39)	0.60(0.23)	86.64
NERICA L-34	8.95(1.58)	1.29(0.17)	85.59	4.22(0.34)	0.62(0.22)	85.31	10.33(2.34)	1.71(0.42)	83.44	4.76(0.39)	0.53(0.23)	88.87
Arica-3	11.14(1.58)	0.89(0.17)	92.01	4.54(0.34)	0.12(0.22)	97.36	12.41(2.34)	0.80(0.42)	93.55	4.48(0.39)	0.31(0.23)	93.08
LSD (0.05)	3.86ns	0.42ns		0.83ns	0.54ns		5.72ns	1.03ns		0.95ns	0.55 ns	

? The LSD are for means along the same column

? ns =Not Significant

? Prot. = Protection

? No-Prot. = No Protection

? * = Significant at 5% probability level (at $P \leq 0.05$)

The avian pests captured and identified during the cause of this study were of the Passeriformes order, they are; *Ploceus melanocephalus* Linnaeus (Ploceidae) – (Plate 1), *Spermestes cucullata* Swainson (Estrildidae) – (Plate 2) and *Ploceus cuculatus* Muller (Ploceidae) – (plate 4) which have common names as Black-headed weaver, Bronze manikin and Village weaver, respectively. The identified rodent pest species responsible for the damage was *Thryonomys swinderialus* Fitzinger (Thryonomyidae) – (Plate 5) with common name as Cane rat or Grasscutter.

Plate 1: Black-headed weaver (*Ploceus melanocephalus L.*)

Plate 2: Bronze mannikin (*Spermestes cucullata S.*)

Plate 3: Rodent's dropping next to damaged rice tillers

Plate 4: Village Weaver (*Ploceus cucullatus M.*)

Plate 5: Suspected Rodent pest (*Thryonomys swinderialus* F.)

DISCUSSION

This study confirms the reports of Adebayo and Ibraheem (1) that rice production is being influenced by several agricultural pests of which vertebrate pests (bird and rodents amongst others) are key constituents. The average infestation levels of rodents and birds over the period of the crop growth was prominent in the no-protection field plots than the protected plots and as a result the damage experienced from these infestations was more prominent under the no-protection field plots which consequently resulted into a heavy crop loss estimate. This finding is in accordance with Khan *et al.* (11) who reported the effectiveness of field protection against avian pests and other crop invaders in rice fields as it considerably reduce losses. The estimated grain yield loss in this study resulted from the combined infestations and damage induced by birds and rodents to the rice varieties and it negates the records of De May *et al.* (4) who reported the yield loss done by birds to cereal crops to be between 13% - 30%, Sarwar, (17) who reported a crop loss by rodents to be about 6.06% and Kasso, (2012) who reported about 50% crop loss caused by rodents to rice crop grown in West Africa.

The avian pests responsible for these recorded losses were morphologically identified to be Passeriformes - *Ploceus melanocephalus Linnaeus (Ploceidae), Spermestes cucullata Swainson (Estrildidae)* and *Ploceus cuculatus* Muller *(Ploceidae)* and it is in accordance with De Mey and Demont, (4) who reported seven important pest bird species of agricultural crops in West Africa. These birds are; *Ploceus cucullatus* (Village Weaver), *Ploceus melanocephalus* (Black-headed Weaver), *Sarkidiornis melanotos* (Knob-billed Goose), *Plectropterus gambensis*

(Spur-winged Goose), *Quelea quelea* (Red-billed Quelea), *Q. erythrops* (Red-headed Quelea) and *Passer luteus* (Golden Sparrow). Among the aforementioned pest birds, only the Spermestes cucullata (Bronze manikin) reported in this study was not included in the list. This could be as a result of all the identified avian pests by De Mey and Demont (4) being indigenous to West Africa while the Bronze manikin (S. cucullata) is highly migratory and as well could be added to the list as pest birds of rice common in West Africa. ***T***he identified rodent pest responsible for the reported losses in this study was *Thryonomys swinderialus* and it corroborates the findings of *Kasso (10) who reported* rodents to be serious agricultural pests in Africa of which he identified a few of them.

CONCLUSION

This research concludes that there is a high infestation and damage levels caused by avian and rodent pests to rice grown in the savanna transition region of Nigeria under a non-protected field and the pests (birds and rodents) if left uncontrolled would cause a huge crop loss. It is noteworthy to state that some of the pest birds responsible for the infestation of the rice fields were Spermestes cucullata (Bronze manikin), Ploceus cucullatus (Village weaver) and Ploceus melanocephalus (Black-headed weaver) amongst several other pest birds while the Thryonomys spp commonly known as the cane rat or grasscutter is the rodent pest responsible for the infestation and consequent damage.

RECOMMENDATIONS

The infestation and damage levels which were higher under the no-protection field plots implies that losses caused by these pests can be minimized or prevented by putting in place adequate field protection measures to minimize the loss. It is therefore recommended that effective control techniques should be devised in order to minimize or totally prevent rice crop loss. One of such protection or preventive techniques to be devised should be effective trapping techniques and the cultivation of lure crops for the control of avian and rodent pests.

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