ASSESSMENT OF SELECTIVE HERBICIDES ON *Orseolia oryzivora* INFESTATION ON GROWTH AND YIELD OF RICE (*Oryza sativa* L.)

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SUMMARY

Rice (Oryza sativa L.) is an important cereal crop with high nutritional value to human beings worldwide. The low yield of rice has been partly, attributed to insect pest damage. Orseolia oryzivora is a serious insect pest of rice for which use of selective herbicides in controlling weeds has been assumed to predispose rice plant to infestation by O. oryzivora. This experiment was conducted in 2020 and 2021 cropping seasons at Edozhigi Niger State, Nigeria (Latitude 9^0 04^1Longitude 6^0 07^1 E), to assess the influence of selective herbicides on O. oryzivora infestation, growth and yield of rice. The experiment was laid out in Randomized Complete Block Design, replicated three times. The treatments were application of Vestermine (2,4 D isobutyl ester), Ricepro (propanil and 2,4 D isobutyl ester), Bracerplus (cyhalofop-butyl 12 % + bspyrbac-sodium 4 %) and hand weeding (without any application of selective herbicide) as control. Data were taken on tiller count, plant height, number of days to 50 % flowering, O. oryzivora incidence and severity, panicle count, panicle length and grain yield. Data were subjected to analyses of variance and significant means were separated using Fisher's Least Significant Difference. The results showed that there were no significant differences ($P<0.05$) in plant height and tiller count among the four treatments in both 2020 and 2021 cropping seasons. The control plot and plots treated with Vestermine and Bracerplus had significantly ($P<0.05$) higher panicles/m^2, and higher grain yield compared to plots treated with Ricepro. Also, plots treated with Ricepro had significantly ($P<0.05$) higher incidence and severity of O. oryzivora compared with other treatments. From the results, it is concluded that the use of Ricepro to control weeds in rice field predisposes rice to infestation and damage by O. oryzivora.

Key words: *Oryza sativa*, Herbicides, *Orzeolia oryzivora*, Infestation

RICE (*Oryza sativa*) is a staple food in many countries of Africa and other parts of the world (FAO, 2020). It is classified as the most important food for over 50 % of the world's population relying on it for about 80 % of food needs (Udemezue, 2014). Sequel to the importance of the crop, FAO estimated that annual rice production should be increased from 586 million metric tons in year 2000 to meet the projected global demand of about 756 million metric tons by 2030 (FAO, 2020). West Africa accounts for 64.2 and 61.9% of total rice production and consumption, respectively in sub-Saharan Africa (AfricaRice, 2019). Nigeria ranks highest as both the producer and consumer of rice in the West African 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 (RIFAN 2017). With 84% of rice being harvested in just 10 countries, it is evident that many countries globally must rely on imports to meet domestic demand (FAO, 2020).

Africa produces the lowest quantity in the world (Hossain, 2006). The production-consumption gap in this region is due to low yield of rice attributed to both abiotic and biotic constraints (Balasubramanian *et al*., 2007). The abiotic constraints include drought, flooding, variabilities in rainfall, extreme temperatures, soil salinity, acidity/alkalinity and poor soils, soil erosion and high phosphorus fixation, while biotic constraints include weeds, blast leaf spots, nematodes in continuously monocropped dry land rice fields (Coyne *et al*., 2004). Insect pests are one of the major constraints in achieving the yield potentials of many varieties of rice (Mohammed *et al*., 2019). African rice gall midge (AfRGM) *Orseolia oryzivora* Harris and Gagné (Diptera: Cecidomyiidae), appears to be the most serious insect pest of lowland and irrigated rice (Ogah *et al.*, 2005, Nwilene *et al*., 2006). Any tiller attack is irreversibly damaged and that affects panicle formation. Consequently, this study is aimed to assess the effect of selective herbicide application on *O. oryzivora* infestation on rice growth and yield in Niger State which is one of the major rice-producing States in Nigeria.

MATERIALS AND METHODS

The experiment was carried out under irrigated lowland ecology in 2020 and 2021 wet seasons at an identified hot spot (Edozhigi) for *O. oryzivora* infestation in Nigeria. The choice of location was because *O. oryzivora* occurs naturally and regularly at levels observed to cause severe damage to rice. The experiment was laid in Randomized Complete Block Design (RCBD) and replicated three (3) times. There were four treatments consisting of application of Ricepro (propanil and 2,4 D Isobutyl ester), Bracerplus (cyhalofop-butyl 12 % + bspyrbac-sodium 4 %), Vestermine (2,4 D Isobutyl ester) and hand weeding as control. The variety used was FARO 44. Data was collected on growth parameters. For tiller count, five rice hills were randomly selected and tillers were counted and averaged. A ruler was used to measure the plant height of five selected plants from the root base to tip of the flag leaf, while the number of days to 50% flowering were counted from transplanting till when half of rice plants had produced panicles. The panicle count per meter square was done by counting plants with panicles within a quadrat of $1m^2$. Grains per panicle were obtained by averaging total number of grains counted from 3 randomly selected panicles, while the grain yield was obtained by weighing grains per plot and expressing the weight in kg/ha. Twenty hills of rice were randomly selected per plot for assessing the incidence and severity of damage due to damage by African rice gall midge at 21, 42 and 63 days after transplanting according to standard evaluation system of International Rice Research Institute (IRRI, 2002). Damage injury rates were calculated as follows:

$$\text{Incidence} = \frac{\text{Number of hills with galls}}{\text{Total number of hills}} \times 100\ \%$$

$$\text{Severity} = \frac{\text{Number of tillers with galls} \times 100}{}$$

Total number of tillers

Data were subjected to analyses of variance (ANOVA) and arcsine-transformed for percentage tiller infestation prior to ANOVA (SAS, 2003). Significant means were separated using Fisher's Least Significant Difference (F-LSD).

RESULTS AND DISCUSSION

In both 2020 and 2021 cropping seasons, there were no significant (P<.05) differences in tiller count among rice plots treated with Vestamin, Ricepro, Bracerplus and the control plot (Table1). Uniformity in tiller count (Table 1), suggested that application of the selective herbicides especially in plots treated with Ricepro despite increasing rate of infestation of *O. oryzivora* did not lead to reduction of tillers per hill of rice in those plots. Thus, tiller range of 18-20 observed in the plots treated with the herbicides may be attributed to the inherent trait of FARO 44 and this affirms earlier report on tillering capacity attributed to this variety by Maji (2015).

There were also, no significant (P<0.05) differences in plant height among the treatments in which selective herbicides were used and those manually weeded (Table1). This indicated that the method of weed control did not affect growth of rice. Ogah *et al.,* (2009) stated that rice hills attacked by *O. oryzivora* grow profusely and become stunted. However, the trend observed in this trial is contrary to his findings as the height of rice treated with Ricepro was similar to other treatments despite having significantly higher *O. oryzivora* infestation.

Rice plots treated with Vestanime, Bracerplus and the control plots attained significantly (P<0.05) higher percentage to 50 % flowering as compared with treated with Ricepro in both 2020 and 2021 cropping seasons. The delay in attainment of 50% flowering observed in rice plots treated with Ricepro may be as a result of higher incidence and severity *O. oryzivora*. Earlier report by Nwilene *et al.* (2006) indicated that any tillers attacked by *O. oryzivora* neither flower nor produced panicles because they are irreversibly damaged.

Table 1: Rice tiller count, plant height and days to 50% flowering as influenced by application of selective herbicides in 2020 and 2021 cropping seasons at Edozhigi, Niger State.

Treatment	Tiller count		Plant height (cm)		Days to 50% flowering	
	2020	2021	2020	2021	2020	2021
Vestamine	18.00	19.33	78.53	78.87	64.67	64.67
Ricepro	18.00	19.67	76.67	67.80	67.00	74.00
Bracerplus	18.33	20.00	79.27	79.27	65.33	65.33
Control	18.33	19.67	80.00	80.00	65.00	60.00
F-LSD	NS	NS	NS	NS	1.10	0.94

Table 2 shows percentage incidence of *O. oryzivora* at 21, 42 and 63 DAT among the four treatments in 2020 and 2021 cropping seasons. At 21 and 42 DAT there were no significant differences in percentage incidence of *O. oryzivora* in plots treated with Vestamine, Ricepro, Bracerplus and the control plots. However, at 63 DAT plots treated with Vestamine, Bracerplus and the control plots had lower percentage incidence of *O. oryzivora* compared with those treated with Ricepro. This result suggested that application of Ricepro predisposed rice to infestation by *O. oryzivora.* This is in line with the findings of Mohammed *et al*. (2019) who observed that application of herbicides has both direct and indirect effect on the microhabitat via biotic interactions.

Table 2: Incidence of gall midge at different days after transplanting (DAT) as influenced by application of selective herbicides in 2020 and 2021 cropping seasons at Edozhigi, Niger State.

Treatment	Incidence (%) of African Rice Gall midge at					
	21 DAT		42 DAT		63 DAT	
	2020	2021	2020	2021	2020	2021
Vestamine	1.67	0.83	2.67	2.33	3.00	3.00
Ricepro	1.00	0.90	3.33	5.33	3.33	5.67
Bracerplus	1.00	0.33	2.50	2.67	2.67	2.57
Control	0.67	0.67	2.33	2.33	3.33	2.67
F-LSD	NS	NS	NS	0.86	NS	1.38

There were no significant ($P<0.05$) variations in percentage severity of Gall midge among rice plots treated with the selective herbicides and the control plot at 21 and 42 DAT in both cropping seasons. However, at 63 DAT plots treated with Vestamine, Bracerplus and the control had lower percentage severity of *O. oryzivora* compared with plots treated with Ricepro. The trend observed on *O. oryzivora* incidences and severity indicated build up at later age (last phase of vegetative growth) of rice growth than the earlier stages (seedling stage or first phase of vegetative growth). The highest incidence and severity were recorded at 61 DAT indicating that the infestation of *O. oryzivora* on rice is not age specific as incidence was noted as early as 21
DAT and continues till 63 DAT. This trend of *O. oryzivora* severity is in conformity with findings of Africarice (2008) which indicated that infestation and damage of *O. oryzivora* in rice field is throughout vegetative stage.

There were no significant (P<0.05) differences in panicle length and 1000 grain weight among the four treatments tested (Table 4) indicating that panicle length and 1000 grain weight were not influenced by variation noted on levels of *O. oryzivora* on rice plots due to the application of selective herbicides. The pest (*O. oryzivora)* does not attack the panicle and grains. This may account for lack of variation on panicle length and 1000 grain weight.

Table 3: Severity of gall midge at different days after transplanting (DAT) as influenced by application of selective herbicides in 2020 and 2021 cropping seasons at Edozhigi, Niger State.

Treatment	Severity (%) of African Rice Gall midge at					
	21 DAT		42 DAT		63 DAT	
	2020	2021	2020	2021	2020	2021
Vestamine	1.50	1.50	2.57	2.40	3.43	3.43
Ricepro	1.57	1.73	2.63	5.33	3.33	6.33
Bracerplus	1.67	1.00	2.67	2.67	3.07	2.73
Control	1.66	1.67	2.66	2.33	2.67	2.67
F-LSD	NS	NS	NS	0.90	NS	1.05

Table 4: Rice panicle length and 1000 grain weight as influenced by application of selective herbicides in 2020 and 2021 cropping seasons at Edozhigi, Niger State.

Treatment	Panicle length (cm)		1000 grain weight (kg/ha)	
	2020	2021	2020	2021
Vestamine	24.31	24.30	30.30	30.30
Ricepro	23.90	23.90	30.33	29.93
Bracerplus	23.55	23.55	30.30	30.30
Control	24.08	24.08	30.00	30.00
F-LSD	0.58	NS	NS	NS

Significant (P<0.05) differences were observed in number of panicles per m^2 in the four treatments evaluated. Rice plots treated with Vestamine, Bracerplus and the control plots had significantly (P<0.05) higher panicles per m^2 compared to those treated with Ricepro. The lower number of panicles per m^2 in plots treated with Ricepro may be linked to the heavy infestation of *Orseolia* o*ryzivora.* This validates the observation of Ogah *et al.,* (2010) who noted that any tiller bearing a gall as a result of *Orseolia oryzivora* attack is irreversibly damaged and does not produce new leaves or panicles.

In 2020 there were no significant (P>0.05) differences in rice grain yield among the four treatments tested. However, in 2021, rice grain yield was significantly (P<0.05) higher in plots treated with Vestamine, Bracerplus and the control plots compared to rice grain yield in plots treated with Ricepro. The resultant lower yields seen in plots treated with Ricepro shows that infestation of rice fields by *O. oryzivora* can lead to substantial yield loss in rice production. This is line with former work of Ogah *et al*. (2009) who observed that *O. oryzivora* is a major insect pest of rice and total crop loss was reported during severe outbreaks in Nigeria. Similarly, Omoloye and Vidal (2007) reported that *O*. o*ryzivora* causes damage to irrigated and rainfed lowland rice crops, with infestation of more than 40 % on farmers' fields (Table 5).

Table 5: Number of rice panicles per meter square and grain yield as influenced by application of selective herbicides in 2020 and 2021 cropping seasons at Edozhigi, Niger State.

Treatment	Number of panicles/m^2		Grain weight (kg/ha)	
	2020	2021	2020	2021
Vestamine	606.00	606.66	3618.50	3633.50
Ricepro	599.67	500.67	3597.33	3146.00
Bracerplus	609.33	607.67	3655.67	3685.03
Control	613.67	617.00	3709.67	3793.33
LSD	10.69	12.85	NS	107.21

In conclusion, some selective herbicides predispose rice to infestation by *Orzeolia oryzivora* and subsequently, lead to reduction in grain yield. Thus, farmers in *Orzeolia oryzivora* endemic areas are advised not to use Ricepro as selective herbicide in management of weeds. Infestation of rice by *Orzeolia oryzivora* is not age specific and thus, control measures should be implemented throughout the vegetative stage.

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