BADEGGI JOURNAL OF AGRICULTURAL RESEARCH AND ENVIRONMENT, 2023, 05(03), 25-32

NCRI Press

Available online: www.ncribjare.org
ISSN: 2695-2122, e-ISSN: 2695-2114
DOI: https://doi.org/10.35849/BJARE202303/115/004
Journal homepage:www.ncribjare.org

Research Article

Effect of Lambda-cyhalothrin + Carbofuran Application and Habitat Modification on Population Dynamics of *orseolia oryzivora* (Diptera: Cecidomyiidae) in Relation to its Parasitoids on Rice

Mohammed, I. G[1]., Isong, A[1]., Fatima, A[1]. J., Shema, A. M[1]., Osipitan, A. A[2]., Aremu, M. B[3]. and Ajao, F. O[4].

[1]National Cereal Research Institute, Baddegi, Niger State.
[2]Department of Crop Protection, Federal university of agriculture, Abeokuta, Ogun state, Nigeria
[3]Nigerian Stored Product Research Institute, Km 3, Asa Dam Road, Ilorin Kwara State
[4]Department of Crop Protection, ModibbAdamauniversityYola, Adamawa state, Nigeria
Corresponding e-mail:*babaisakoko@yahoo.com*

Abstract

This experiment was carried out between 2018 and 2019 at the experimental site of the National Cereals Research Institute's identified hot spot (Edozhigi) for the African rice gall midge (*0rseoliaoryzivora)* infestation in Nigeria. Edozhigi in Niger State is within the southern Guinea savanna agro-ecological zone at latitude 09°45' N, longitude 06°07' E, to test the integrated influence of habitat manipulation, lambda-cyhalothrin and carbofuran on population dynamics of *0. oryzivora* in relation to its parasitoids on rice. The treatments were arranged in a split-plot and laid out in an RCBD with three replicates. Data were collected on the number of tiller/stand, plant height, days to 50 percent flowering, percent incidence, percent severity, percentage parasitism of *0.oryzivora*, panicle per meter square, grains per panicle and yield of rice. Data collected were subjected to Analysis of Variance and significant means were separated using the Student Newman Keuls Test, (SNK) at 5 % probability. The result showed that rice plots treated with *P. scrubiculatum* + 0.38L/ha lambda-cyhalotrin +3.75kg/ha carbofuranhad lower incidence (2.36) and severity (1.54) of *0. oryzivora*compared with incidence (7.99) and severity (7.40) respectively found in untreated plots (control). It also had a significantly higher yield (3263.95kg/ha) compared with the yield (2688.28kg/ha) in control plots. In conclusion, having *P. scrobiculatum* at the boarder of net plots enhanced the number of parasitoids and reduced the attack on rice by *0. oryzivora.* Integration of habitat modification with insecticide application offers better protection of rice against *O. oryzivora*.

Keywords:*Habitat P. scrobiculatum, Infestation, Modification, Galls*

Introduction

Rice is the most eaten staple food across the universe. Half of the global population relies on rice as a major part of their diet. In fact, rice is seen as a valuable part of nutrition in most of Africa, America, Asia, and the Caribbean, and is projected to provide more than one-fifth of the calories consumed worldwide by humans. The total world rice production for 2021 was 787,293,867 metric tonnes (F.A.O. 2022). Consequent to the high demand for rice, FAO estimated that yearly rice production should be increased from 686 million metric tons in 2020 to meet the projected world requirement of about 856 million metric tons by 2030 (F.A.O 2022; Udemezue, 2014). In Nigeria, consumption is increasing due to an increase in internal cultivation of the rice. The utilization volume now is 7.9 million tonnes while the production volume has risen to 5.8 million tonnes per year (RIFAN 2017). Rice is cultivated and used in many ways. In the Philippines, polished rice residue is used as a source of Vitamin B to prevent and cure beriberi, (Muzaffar*et al.*,2005).

Received on 6th August, 2023; Revised on 17th October, 2023; Accepted on 4th November, 2023 and Published on 30th December, 2023

The by-products of processing, such as bran and rice polish (finely ground bran and starch obtained from polishing), are occasionally used as livestock feed. Oil is extracted from the bran for dual purpose. Broken rice is used in making alcohol and in the manufacture of starch and rice flour. Hulls are used for fuel, industrial grinding, packing material, fertilizer manufacture, and in the making of an industrial chemical called furfural. The straw is used for livestock bedding, mats, garments, roof thatching, packing material, and broom straws. Despite rice assuming an important status, its production in Africa is still at the bottom of the world and failed to meet the increasing demand for rice in several African nations (Balasubramanian*et al.*,2007). Until this situation is changed, food dependency will rise in the greater part of the continent. The production-consumption gap in the continent is a result of the low yield of rice (AfricaRice, 2007). A wide range of constraints affect rice production in Nigeria. Including; biotic, abiotic and little utilization of good agronomic practices (Ngala 2013). The abiotic stressors include low soil fertility, flooding, fluctuation in rainfall patterns, extreme temperatures, salinity, drought and soil erosion. The biotic stressors include weeds, fungi, bacterial, viral diseases, and many pest problems in both upland and lowland rice fields (Coyne *et al*., 2004). The major insect pests that attack rice include., *Sesamiacalamistis*, gall midge, termites *Aspaviaaemigera*, birds and rodents (Cheseriek*et al.*, 2017). African rice gall midge (AfRGM) *Orseoliaoryzivora* is the most serious insect pest of lowland and irrigated rice in recent times (Bâ, 2003., Ogah *et al*., 2005, 2006; Nwilene*etal*., 2006). *0. oryzivora* attacks rice at the growing phase and destroys the growing primordia, which results in the formation of a tubular structure referred to as a gall or onion shoot. Infestation of seedlings and consequent sap sucking by *0.oryzivora* larvae lead to profuse tillering and stunting of rice. Damage caused by *0. oryzivora* can reach 80% and total crop failure is possible in endemic areas (Heinrichs and Barrion, 2004**).** The aims of this work were: To evaluate the influence of insecticide combination and habitat manipulation on the population dynamics of *0rseoliaoryzivora*and to determine the degree of parasitism of *0rseoliaoryzivora* by parasitoids (parasitized larvae and pupae).

Materials and Methods

This experiment was done in irrigated lowland ecology in the 2018 - 2019 cropping seasons at (Edozhigi) the location known for regular infestation of *Orseoliaoryzivora* in Nigeria. Edozhigi is located in the southern Guinea savanna agroecological zone at latitude 09°45' N, and longitude 06°07' E. The experimental design was split-plot arranged in a Randomized Complete Block Design (RCBD) and was replicated (3) times. The main plot treatments were FARO 37 and FARO 51. While, sub-plot treatments were**:** *P. scrubiculatum* + 0.38 lambda-cyhalothrin/ha + 3.75kg of carbofuran/ha, *P.scrubiculatum* + 0.25 L lambda-cyhalothrin/ha+ 2.50 kg of carbofuran/ha, 0.38 L lambda-cyhalothrin/ha + 3.75 kg of carbofuran/ha and no application of insecticide combination without habitat management as (control). The land was prepared mechanically using a power tiller to puddle the field. Nursery beds were prepared and seedlings were kept in the nursery for 21 days when they were transplanted to the permanent site. Seedlings were transplanted at a rate of one/stand and were planted in rows using a spacing of 20 cm x 20 cm inter- and intra-spacing. Application of NPK(15:15:15) Fertilizer was done at the dose of 40 kg/ha of N, P_2O_5 and K_2O using as the basal application while the second dose of Nitrogen 40kg/ha was applied again at 3 weeks after transplanting. Herbicide was used for weed management with supplementary hand weeding. Observations were made and the following parameters were measured: Tiller number, Plant height (cm), days to 50 percent flowering, Panicle/m^2, Grains/panicle, Grain yield, percentage incidence and severity of damage caused by AfRGM at 20, 40 and 60 days after transplanting (DAT) (IRRI, 2003) by selecting five tillers at random and using formula below to calculate injury level:

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

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

Checking for the presence of parasitized larva and pupae of AfRGM by parasitoids at 20, 40. And 60 DAT was done by dissecting 5 galls formed on the rice tiller. Analysis of Variance (ANOVA) was carried out on the data obtained. An arcsine transformation was carried out on % tiller infestation and % parasitism data before ANOVA (SAS, 2003). The significant means were separated using the Student Newman Keuls Test, (SNK) at 5 % probability.

Results and Discussion

Table 1 shows that in both 2018 and 2019, significant (P<0.05) differences exist in tiller number, between the two varieties tested. FARO37 had a significantly higher tiller number compared to FARO51. However, there was no significant (P>0.05) difference in rice tiller number among different rates of insecticide combinations and habitat modification tested. FARO51 had significantly (P<0.05) taller plant height compared to FARO37 in both 2018 and 2019. Whereas, no significant difference in plant height among varied rates of insecticide combination application and habitat modification was tested (Table 1). The absence of significant difference in both plant height and tiller number of rice among various integrated levels of insecticide combinations and habitat management indicates that the combination of insecticides and habitat management in control of (*0rseolia*. *oryzivora)* in rice fields neither increase nor decrease the number of tillers produce by the rice nor influence the inherent height of the rice. Therefore difference seen in plant height and number of tiller among the two varieties evaluated is due purely to their inherent trait. Attainment of 50 percent flowering was earlier in FARO51 than in FARO37 in both 2018 and 2019 (Table 1). Whereas, the attainment of 50 percent flowering among rice applied with different insecticide Combinations and habitat manipulation significantly followed this order in 2018 P.*scrubiculatum*+ Lambda-cyhalothrin 0.38 L/ha + Carbofuran3.75kg/ha <P.*scrubiculatum*+ Lambda-cyhalothrin 0.25L/ha + Carbofuran 2.5kg/ha <P.*scrubiculatum* = Lambda-cyhalothrin 0.38 L/ha + Carbofuran 3.75 kg/ha = control. While in 2019 the attainment of 50 % flowering significantly followed this order: P. *scrubiculatum*+ Lambda-cyhalothrin 0.38L/ha + Carbofuran 3.75kg/ha < P. *scrubiculatum*+ Lambda-cyhalothrin 0.25 L/ha + Carbofuran 2.5 kg/ha <P.*scrubiculatum*< Lambda-cyhalothrin 0.38L/ha + Carbofuran3.75 kg/ha < control in 2018 and 2019 planting seasons (Table 1). The significant variation seen in days to 50 percent flowering of rice among various integrated levels of insecticide combinations and habitat management suggested that the combination of insecticides and habitat management in control of *Orseolia*. *oryzivora* in rice fields can increase the number of days growing rice takes to attain 50 percent flowering as is seen in rice plots applied with P. *scrubiculatum*+ Lambda-cyhalothrin at the dose of 0.38L/ha and Carbofuran at the rate of 3.75kg/ha attained 50 percent flowering faster than attainment of 50 percent flowering recorded in plots applied with other levels of insecticide combination and habitat management. This variation in the attainment of 50 percent flowering is an indirect effect resulting from lower infestation and subsequent lower damage of tillers of rice by *Orseolia*. *oryzivora* in rice plots applied with P. *scrubiculatum*+ Lambda-cyhalothrin at the dose of 0.38L/H and Carbofuran at the rate of 3.75kg/ha, this confirms the earlier finding of (Nwilene *et al.,* 2006) who noted that any tiller attacked by (*Orseoliaoryzivora)* neither flower no produce panicle. Significant (P<0.05) variation was observed in % incidence of (*Orseoliaoryzivora)* between the two rice varieties and rates of insecticides evaluated in 2018 and 2019. FAR051 had a significantly (P<0.05) lower % incidence of *Orseoliaoryzivora* at 20, 40, and 60 DATcompared with the % incidence of *0rseoliaoryzivora* seen in plots planted with FAR037 (Table 2). Rice plots surrounded by *P. scrubiculatum*and treated with Lambda-cyhalothrin 0.38 L/ha + Carbofuran 3.75 kg/ha, had Significantly (P<0.05) lower % incidence of (*Orseoliaoryzivora)* at 20, 40, and 60 DATcompared with % incidence of *0rseoliaoryzivora* in plots surrounded by *P. scrubiculatum*and treated with Lambda-cyhalothrin 0.25 L/ha + Carbofuran 2.5 kg/ha, *P. scrubiculatum* +Lambda-cyhalothrin 0.38L/ha + Carbofuran 3.75kg/ha and control plots had the highest incidence of *0rseoliaoryzivora* in both 2018 and 2019 (Table 2). FARO51 had a significantly (P<0.05) lower % severity of *0rseoliaoryzivora* at 20, 40, and 60 DATcompared with the % severity of *Orseoliaoryzivora* present in plots planted with FARO37 in both years (Table 3). There was also a significant (P<0.05) variation in % severity of *Orseolia*. *oryzivora* among various rates of insecticide application. Rice plots applied with P.*scrubiculatum*+ Lambda-cyhalothrin 0.38L/ha + Carbofuran 3.75kg/ha, had Significantly (P<0.05) lower % severity of *Orseolia*. *oryzivora* at 20, 40, and 60 DATcompared with % severity of *Orseolia*. *oryzivora* in plots applied with P. *scrubiculatum*+ Lambda-cyhalothrin 0.25L/ha + Carbofuran 2.5kg/ha, P. *scrubiculatum* Lambda-cyhalothrin 0.38L/ha + Carbofuran 3.75kg/ha and control plots had the highest severity of *Orseolia*. *oryzivora* in 2018 and 2019 cropping seasons (Table 3).

Lowest *Orseolia*.*oryzivora* infestation of rice in the plots treated with various integrated levels of insecticide combinations and habitat manipulation indicates that the combination of insecticides and habitat manipulation in control of *0rseolia*. *oryzivora* can be an effective way of managing it in rice fields with less negative impact on the environment and saving the cost of higher doses of insecticide application. This is because even the smaller doses of insecticide combination (P.*scrubiculatum*+ Lambda-cyhalothrin at a rate of 0.38L/ha and Carbofuran at a rate of 3.75kg/ha) in integration with habitat management became highly effective in reducing incidence and severity of *0rseolia*. *oryzivora* this result is in line with the findings of IRRI 2017 that observed the best approach in managing *0rseolia*. *oryzivora* in rice fields is (IMP) integration of different control measures. There was no significant (P>0.05) difference in % parasitism of *0rseolia*. *oryzivora* between the two varieties evaluated, however, there was a significant (P<0.05) difference in % parasitism of gall midge among rates of insecticides combination and habitat management applied. In 2018 cropping season at 20, 40 and 60 DAT plot applied with P. *scrubiculatum* only had the highest *0rseolia*. *oryzivora* percentage parasitism, while plots treated with P. *scrubiculatum*+ Lambda-cyhalothrin 0.38L/ha + Carbofuran 3.75kg/ha, P. *scrubiculatum*+ Lambda-cyhalothrin 0.25L/ha + Carbofuran 2.5kg/ha, had moderate parasitism of Africa rice gall midge and the lowest parasitism of *Orseolia*. *oryzivora* was found in plots applied with Lambda-cyhalothrin 0.38L/ha + Carbofuran 3.75kg/ha (Table 4). Similar pattern of *0rseolia*.*oryzivora* % parasitism observed in the 2018 cropping season was also seen in 2019 (Table 4). All levels of integration of insecticide combinations and habitat management (P. *scrubiculatum*+ Lambda-cyhalothrin at the rate of 0.38L/ha and Carbofuran at the rate of 3.75kg/ha, P. *scrubiculatum*+ Lambda-cyhalothrin at the rate of 0.25L/ha and Carbofuran at the rate of 2.5kg/ha, P. *scrubiculatum*,) evaluated in this trial gave higher parasitism of African rice gall midge in rice field compared to a single application of insecticides (Lambda-cyhalothrin at the rate of 0.38L/h and Carbofuran at the rate of 3.75kg/ha). This suggests that habitat management helps in the conservation of natural enemies of *0rseoliaoryzivora* which ecologically check their build up in rice fields. This is in line with the observation of (Mohammed *et al.,* 2022) that the presence of P. *scrubiculatum* at the edge of rice plots encourages the buildup of parasitoids of *0rseoliaoryzivora* which parasitize on its eggs and larva.

There was a significant (P<0.05) difference in panicle/m^2 between the two varieties evaluated. Faro51 had significantly (P<0.05) higher panicle/m^2 compared to panicle per meter square of Faro37. Whereas, the highest panicle/m^2 was obtained in plots applied with *P*. *scrubiculatum*+ Lambda-cyhalothrin 0.38 L/ha + Carbofuran 3.75 kg/ha. The lowest panicle/m^2 was seen in plots treated with *P.scrubiculatum*, Lambda-cyhalothrin 0.38 L/ha + Carbofuran 3.75 kg/ha and where there was no application of insecticide.

There was no significant (P>0.05) difference in grains/panicles among the two varieties evaluated and also among the various rates of insecticide combination applications and habitat modifications (Table 5). There was a significant

(P<0.05) difference in grain yield between the two varieties tested. Faro51 had a significantly (P<0.05) higher grain yield compared to the grain yield of Faro37. Also rice grain yield was significantly (P<0.05) higher in plots treated with P.*scrubiculatum*+ Lambda-cyhalothrin 0.38 L/ha + Carbofuran 3.75kg/ha compared to rice grain yield in plots treated with P.*scrubiculatum*+ Lambda-cyhalothrin 0.25L/ha + Carbofuran 2.5kg/ha, and P.*scrubiculatum*, while the lowest grain yield was seen in the controlled plots (Table 5). The lowest yields in controlled plots show that heavy infestation of this pest organism on rice can alter its flowering and subsequently affect rice yield. This validates the findings of (Souleymane*et al.*, 2016). Who observed that one percent of tillers were damaged by *0rseolia*.*oryzivora* in rice fields resulted in a 2% grain yield loss.

Conclusion

Combined application of lambda-cyhalothrin and Carbofuran had complementary effect in the control of *O. oryzivora*. Planting of *P. scrobiculatum* at hedgerow enhanced build up of parasitoids and reduced infestation of rice by *O. oryzivora.* Integration of habitat modification with insecticide application offers better protection of rice against *O. oryzivora* and is recommended to mitigate the deleterious effect of insects.

References

Africa Rice Center, (2007). Africa rice Trends; Overview of recent developments in the sub- Saharan Africa rice sector, Africa Rice Center (WARDA) Brief, Cotonou, Benin. 8pp.

Bâ, N.M. (2003). Annual cycle of the African rice gall midge, *Orseoliaoryzivora*Harris and Gagne (Diptera: Cecidomyiidae) in relation with its plants hosts, its parasitoids and certain cultural practices in the Southwest of the Burkina Faso. Doctoral thesis, Universite of Ouagadougou, Ouagadougou, Burkina Faso.*A Development Association* 2(2):5-6.

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.

Cheseriek, G. J., Kipkorir, E. C., Webi, P.O.W., Daudi, K.K.G., Mugalaraic, E. M., Kiplagat, K.L. and Songok, C.K. (2017) Assessment of farmers challenges with the rice productivity in selected irrigation schemes in Western Kenya. *International Journal of Current Research*. 4 (08): pp 025-033

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. (2022). FAO Rice Information 3: p2

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

International Rice Research Institute (IRRI)(2003). Standard Evaluation System for Rice, International Rice Research Institute. Los Banos, Philippines. 71pp

Linares, O. F. (2002). African rice (*Oryzaglaberrima*) history and future potential, proceeding of *National Academy of Science of the United States of America* 99; 16369-16365.

Mohammed, I. G., Osipitan, A. A., Pitan,O. O and Adigbo, O. O (2019). Habitat management influence of *Orseoliaoryzivora* and its parasitoids on Rice.*Badeggi Journal of Agricultural Research and Environment 01(01), pp58-65*

Muzaffar, D.T.A., Khoo, K.K and Selvamany, G. (2005).The of Medicine in Malaysia, the foundation years. Academy of Medicine, Kaula Lumpur, Malaysia.120 p.

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

Ngala G. N. (2013). Constraints to increase quality rice production for food, market and development with special reference to tropical Africa. Africa Crop Science Conference Proceedings, 11: pp617- 620

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, *Orseoliaoryzivora*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 Orseoliaoryzivora (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.

Souleymane, N.,Elvis, A. H, and Dona, D. (2016). Estimation of rice yield losses due to the African rice gall midge, Orseoliaoryzivora Harris and Gagne*International Journal of Pest Management*10/1996; 42(4):331-334.

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

Table 1: Tiller number, plant height and days to 50 percent flowering as affected by application of combined insecticides application and habitat modification

Treatments	Tiller count			Plant height			50% flowering		
	2018	2019	Means	2018	2019	Means	2018	2019	Means
Variety(V)									
FARO 37	16.60a	17.27a	16.94a	98.25a	98.48a	98.37a	90.87a	89.33a	90.10a
FARO 51	14.27 b	14.73 b	14.50 b	95.91 b	95.69 b	95.80 b	85.60 b	83.53 b	84.57 b
Insecticide Application(I)									
P.scrubiculatum+Lc 0.38L/ha+Carbofuran3.75kg/ha	15.67a	16.50a	16.09a	97.08a	97.45a	97.27a	76.83c	78.17[e]	77.50 d
P.scrubiculatum+Lc 0.25L/ha+Carbofuran 2.5kg/ha	15.33a	15.83a	15.58a	97.10a	97.10a	97.10a	82.83 b	82.83 d	82.83c
P.scrubiculatum	15.17a	16.17a	15.67a	97.22a	97.03a	97.13a	93.00a	93.33 b	93.17a
Lambda-cyhalothrin 0.38L/ha+Carbofuran3.75kg/ha	15.33a	15.67a	15.50a	96.70a	97.03a	96.87a	94.00a	94.17a	94.09a
Control	15.67a	15.83a	15.75a	97.30a	96.80a	97.05a	94.50a	83.67c	89.09 b
CV %	5.07	4.39	4.65	0.85	1.34	1.05	1.24	0.85	1.00

Means carrying the same letter in a column did not differ significantly at 5 % Student Newman Keuls (SNK) Test, DAT= Days After, Transplanting, LC = Lambda-cyhalothrin and C = Carbofuran

Table 2: *0rseolia. oryzivora* incidence at 20, 40, and 60 DAT as affected by insecticide combined application and habitat modification

Treatments	Incidence 20		Incidence 40		Incidence 60		
	2018	2019	2018	2019	2018	2019	Means
Variety(V)							
FARO 37	4.63a	4.51a	4.56a	4.29a	4.63a	4.54a	4.53a
FARO 51	2.21b	2.17b	2.23b	2.14b	2.61b	2.38b	2.29b
Insecticide Application(I)							
P.*scrubiculatum*+LC 0.38L/ha+Carbofuran3.75kg/ha	1.47c	1.45c	1.32c	1.22c	1.28c	1.40c	1.36c
P.*scrubiculatum*+LC 0.25L/ha+Carbofuran 2.5kg/ha	2.70b	2.68b	2.33b	2.33b	2.20b	2.20b	2.41b
P.*scrubiculatum*	2.53b	2.65b	2.87b	2.97b	2.46b	2.47b	2.66b
Lambda-cyhalothrin 0.38L/ha+Carbofuran3.75kg/ha	2.67b	2.42b	2.78b	2.17b	2.78b	2.93b	2.63b
Control	7.73a	7.50a	7.67a	7.38a	9.37a	8.30a	7.99a
CV %	17.10	20.30	15.50	18.30	18.40	16.50	17.68

Means carrying the same letter in a column did not differ significantly at 5 % Student Newman Keuls (SNK) Test, DAT= Days After, Transplanting, LC = Lambda-cyhalothrin and C = Carbofuran

Table 3: *0rseolia. oryzivora* severity at 20, 40, and 60 DAT as affected by insecticide combined application and habitat modification

Treatments	Severity 20		Severity 40		Severity 60		
	2018	2019	2018	2019	2018	2019	Means
Variety(V)							
FARO 37	3.81a	4.25a	5.06a	4.85a	5.33a	5.18a	4.75a
FARO 51	2.51b	2.22b	2.43b	2.10b	3.59b	3.23b	2.68b
Insecticide Application(I)							
P.*scrubiculatum*+Lc.0.38L/ha+Carbofuran3.75kg/ha	1.45c	1.57d	1.48c	1.48c	1.57c	1.67c	1.54c
P.*scrubiculatum*+Lc.0.25L/ha+Carbofuran 2.5kg/ha	1.91bc	2.18c	3.27b	3.20b	4.43b	3.95b	3.16b
P.*scrubiculatum*	2.15bc	2.72bc	2.85b	2.87b	3.87b	3.72b	3.03b

Lambda-cyhalothrin,0.38L/ha+Carbofuran3.75kg/ha	2.88b	3.20b	2.92b	2.92b	4.43b	4.43b	3.46b
Control	7.40a	6.50a	8.22a	6.92a	8.00a	7.37a	7.40a
CV	25.0	15.6	16.5	19.3	11.8	18.4	17.77

Means carrying the same letter in a column did not differ significantly at 5 % Student Newman Keuls (SNK) Test, DAT= Days After, Transplanting, LC = Lambda-cyhalothrin and C = Carbofuran

Table 4: Gall midge parasitism at 20, 40, and 60 DAT as affected by insecticide combined application and habitat modification

Treatments	Parasitism20		parasitism40		parasitism60		Means
	2018	2019	2018	2019	2018	2019	
Variety(V)							
FARO 37	0.53a	0.53a	0.93a	0.73a	0.73a	0.73a	0.70a
FARO 51	0.67a	0.33a	0.53a	0.67a	1.00a	0.67a	0.65a
Insecticide Application(I)							
P.scrubiculatum LC.0.38L/ha+Carbofuran3.75kg/ha	0.50b	0.33b	0.50b	0.67b	0.50b	0.33b	0.47b
P.scrubiculatum+LC.0.25L/ha+Carbofuran 2.5kg/ha	0.50b	0.33b	0.50b	0.33b	0.50b	0.33b	0.42b
P.scrubiculatum	1.00a	1.67a	1.83a	2.00a	2.17a	1.50a	1.70a
Lambdacyaholotrin,0.38L/ha+Carbofuran3.75kg/ha	0.33b	0.50b	0.33b	0.33b	0.33b	0.50b	0.39b
Control	0.67b	0.33b	0.50b	0.67b	0.83b	0.83ab	0.64b
CV %	71.70	88.20	81.32	82.94	61.65	82.93	78.10

Means carrying the same letter in a column did not differ significantly at 5 % Student Newman Keuls (SNK) Test, DAT= Days After, Transplanting, LC = Lambda-cyhalothrin and C = Carbofuran

Table 5: Panicle/m^2, Grains/panicle and grain yield as affected insecticide combined application and habitat modifications

Treatments	Panicle/ m^2			Grains/panicle			Grain yield kg/ha		
	2018	2019	Means	2018	2019	Means	2018	2019	Means
Variety(V)									
FARO 37	273.13b	277.60b	275.37b	295.60a	295.07a	295.34a	2772.91b	2815.16b	2794.04b
FARO 51	309.73a	307.07a	308.40a	293.73a	292.33a	293.03a	3018.45a	3053.51a	3035.98a
Insecticide Application(I)									
P.scrubiculatum+LC0.38l/ha+C	327.33a	343.33a		298.00a	297.50a		3205.77a	3322.13a	
3.75kg/ha			335.33a			297.75a			3263.95a
P.scrubiculatum+LC0.25l/ha+C	284.83b	294.67b		298.00a	296.67a		2948.53b	3025.35b	
2.5kg/ha			289.75b			297.34a			2986.94b
P.scrubiculatum	288.00b	276.50c	282.25bc	295.50a	294.00a	294.75a	2886.20b	2905.57b	2895.89b
Lc	286.83b	277.00c		288.17a	286.83a		2750.87c	2729.10c	
0.38L/H+Carbofuran3.75kg/ha			281.92bc			287.50a			2739.99c
Control	270.17c	270.17c	270.17c	293.67a	293.50a	293.59a	2687.02c	2689.53c	2688.28c
CV	5.04	3.23	4.10	3.65	3.90	3.75	5.35	4.98	5.10

Means carrying the same letter in a column did not differ significantly at 5 % Student Newman Keuls (SNK) Test, DAT= Days After Transplanting, LC = Lambda-cyhalothrin and C = Carbofuran