Scholars Journal of Agriculture and Veterinary Sciences (SJAVS) **e-ISSN 2348–1854**
Abbreviated Key Title: Sch. J. Agric. Vet. Sci. **p-ISSN 2348–8883**
©Scholars Academic and Scientific Publishers (SAS Publishers)
A Unit of Scholars Academic and Scientific Society, India
www.saspublishers.com

Evaluation of the Major Factors Associated in Controlling of Brown Planthopper (*Nilaparvata lugens*) in Paddy Cultivation during Its Outbreak in Selected Divisional Secretariats of the Ampara District of Sri Lanka

Nishanthi Sivasubramaniam[1]*, Mohammeth Saleem Mohammeth Imthiyas[2]
[1]Department of Agricultural Biology, Eastern University Sri Lanka, Vantharumoolai, Chenkalady, Sri Lanka
[2]Sri Lanka School of Agriculture, Palamunai, Sri Lanka

Original Research Article

***Corresponding author**
Nishanthi Sivasubramaniam

Article History
Received: 01.11.2018
Accepted: 10.11.2018
Published: 30.11.2018

DOI:
10.36347/sjavs.2018.v05i11.003

Abstract: A survey was conducted at Nintavur and Uhana DS areas of Ampara District to evaluate the factors associated with the controlling of Brown Planthopper in paddy fields during its out breaking condition and the measures on the adopted controlling mechanisms. Among the BPH outbreak experienced farmers in 2018 *Yala*, 50 farmers were randomly selected and interviewed through structured pre-tested questionnaires. Generated responses were analysed using descriptive statistics. Most of the farmers (80%) identified BPH outbreak at 46 to 66 days after sowing of paddy with the visible symptoms such as yellowing (40%), lodging and hopper burn (60%). About 88% of the farmers relied solely on pesticides used to control BPH outbreak. Further, the farmers used variety of pesticides belongs to various chemical groups with various formulations such as sulfloxyflor 50% WG, Carbosulfan 20 SC, Imidaclobrid 70% WG and Ethiprole 10 SC. By altering the mode of action, famers used different combinations of said chemicals. Out of all combinations, majority of the farmers (56%) reported that Carbosulfan 20 SC+ Sulfloxyflor 50% WG (Transform TM) followed by Imidaclobrid 70% WG +Sulfloxyflor 50% WG (24%) and Ethiprole 10 SC+ Sulfloxyflor 50% WG (8%). The average yield obtained during this outbreak was 45 to 60 bushels per acre by 56% of farmers followed by 61 to 71 bushels per acre by 36% of farmers. Therefore, it could be concluded that the controlling of BPH during outbreak could be achieved by choosing pesticides those have completely different mode of action till realize the acceptable one for minimizing the effects. Further, combination of pesticides which has the active ingredient of sulfoxyflor 50% WG (4C Sulfoximines) would be the best solution for controlling BPH outbreak out of available chemicals in the market.
Keywords: BPH outbreak, Brown Planthopper, Hopper burn, Paddy, Sulfloxyflor 50% WG, Yellowing.

INTRODUCTION

Rice (*Oryza sativa* L.) is the principal food in Sri Lanka and is the most single important crop occupying the 34% among the total cultivatable land. Over 1.8 million farm families are engaging in the production of 2.7 million rough rice annually which encountering the 95% of the domestic requirement [1]. The projection of the demand is cumulatively produced annually in 1.1% and to replenish this, the production should be increase at the rate of 2.9%. Increasing the cropping intensity and national yield are the vanquish options to Sri Lanka to achieve this target [2]. In the total production of rough rice, among the major rice producing districts, Ampara conferring the predominant role than all other districts in Sri Lanka. Paddy production in Ampara district was accounted for about 21% of rice production of the country in 2017 [3]. Further, the cultivation of 108,310 acres, 5,573 acres and 532 acres of rice were also reported from Major Scheme, Minor Scheme and Rain fed schemes in 2017, respectively. The average net yield of 2017 *Yala* was 83.2 bushels per net acre [3].

It seems impossible to maintain the sustainability of the progress path due to various obstacles. One of the prime problems is the different kind of pest attacks on the rice fields. The profit margin of the rice production directly correlated with pest and diseases intensifying at field. The BPH, *Nilaparvata lugens* (Order: Hemiptera) has in recent years become an important insect pest of rice in Asia [4] including Sri Lanka. It is common in rain fed and irrigated paddy cultivation throughout the reproductive stage of the rice plant. The nymphs and adults of the insect are typically found at the bases of the crop cover, where it is shady and humidness is high [5]. Outbreak frequency of BPH has been increasing in Asian rice growing countries in recent years [6]. These trends are widely linked to adverse effects on BPH natural enemies of the increased use of broad spectrum

insecticides for control of a range of pests [7-9]. Further, it was also reported that the recent increase in damage and in population density may be related to climate and the growing of the new, high yielding rice with modern technology [10].

In Ampara, there was a BPH outbreak occurred during 2018 *Yala* season and it was buoyantly controlled with the efforts made by the Department of Agriculture. There is an urgent need to investigate the factors such as pre seasonal history, agronomic practices, crop management practices with the special emphasize on control measures adopted and thus preventing future BPH outbreak in Ampara district. In this regard, a questionnaire survey was designed to evaluate the factors associated with the controlling of Brown Planthopper in paddy fields during its out breaking condition and the measures on the adopted controlling mechanisms from selected Divisional Secretariats (DS) areas of the Ampara district.

METHODOLOGY

Description of the Study Area

The Ampara district is located in the south-east of Sri Lanka and it is part of the Eastern Province. The district of Ampara covers an area of 4,415sq. Surface km and 193sq area of km of water. The district of Ampara consists of 20 DS. The mean temperature is 30^{o}C. Highest temperature is 36^{o}C. The lowest temperature is 24^{o} C during December and January periods. The Ampara district is situated in the dry zone of the country and received an annual rainfall of 1400 mm mainly during North-East monsoon season. The district experiences dry season from March to September (*Yala*) and the rainy season from October to February (*Maha*).

Study Design

The study was conducted in selected DS areas (Nintavur and Uhana) of Ampara district, Sri Lanka, from August to October 2018. The population of this study was consisted of farmers experienced on the BPH problems in their fields during this out break. Purposive sampling was done for the selection of DS and random sampling method was performed for the selection of farmers which predominantly affected by the BPH outbreak. Total study populations of 50 farmers (n=50) were interviewed from the selected DS areas due to limited time, financial constraints and is enough for statistical analysis such as descriptive, correlation and chi – square test

Data collection Procedures

Data were collected through face to face interviews with the sampled farmers using a pre-tested and back translated questionnaire. Informed consent was taken from participants, after explaining of research which included the purpose, the nature of the study and the potential benefits of the research. Then, the interviewer-administered questionnaire was filled by the principal and co investigators according to their answers. Secondary data were collected from reports available from Central Bank of Sri Lanka, Department of Census and Statistics, Department of Agriculture, District Secretariat of Ampara, journals, websites and the Agriculture Instructors who are working in the region.

Data validation

All questionnaires were filled by the principal and co investigators according to respondents' answers. Native language of respondent was used without technical terms and it was understandable to the participant's educational state. For the unclear parts further explanation was provided.

STATISTICAL ANALYSIS

The collected primary data were coded, entered, cleansed, and analyzed using the Statistical Package for Social Science (SPSS) version 22. Descriptive statistics such as frequency and percentage were calculated to determine distribution of the study variables. Correlation and Chi-square test were used to test the significance difference between variables under investigation. The significant level of 0.05 (95%) was selected as a criterion for determining significances.

RESULTS AND DISCUSSIONS

General Details of sample respondents

It was recorded that mainly male (96%) were incorporating their knowledge and skills in the paddy cultivation while a smaller number of females involved in weeding and harvesting practices in selected DS areas of the Ampara district. It seems that the decision-making process in paddy cultivation mainly led by the male in the study area. In the present study, the sample farmers were categorized into five groups with respect to literacy status. Among the respondents, 52% of farmers completed secondary school till Grade 10. The expertise of the farmers brings the correct level of selection of control measures. Age has a bearing on the farmer's risk-taking attitude and innovativeness in diagnosing on damage symptoms in early sage and adopting suitable control measures. Out of the total sample, majority of the farmers were in the age category of 41-50.

Table-1: Demographic Distribution of Sample Respondents who are Experienced with BPH Outbreak during 2018 *Yala* Season from Selected DS Areas of the Ampara District

Variables	Categories	Frequency (N=50)	Percentage (%)
Gender	Male	48.0	96.0
	Female	02.0	4.0
Age (Years)	Below 20	0.0	0.0
	21-30	3.0	4.0
	31-40	8.0	16.0
	41-50	26.0	52.0
	Above 51	13.0	26.0
Education	Never attended school	1.0	4.0
	Did not complete primary education (grade 1-5)	2.0	2.0
	Completed primary education (grade 1-5)	10.0	20.0
	Completed secondary school (Grade 10/ failed O/L)	26.0	52.2
	Passed O/L Exam	11.0	22.0

History of Pre-Seasonal Cultivation

Analyzing the pre-seasonal cultivation is the highlighting aspects while considering the current level of pest out breaks (Table 2). Majority of the sample respondents (82%) involved in the cultivation of 3.5-month variety. Further, majority of the farmers (60%) emphasized that the prevailed UN favorable weather condition during pre-season (*Maha*). However, about 80% of the respondents were not encountered in severe pest problems meantime 88% of them did not enlighten in the facing of severe disease problems. Due to this phenomenon, during *Maha* which means pre–season, average yield was obtained in the range, 61-71 bushels per acre, which marked 62%, indicate that the level of production did not considerably affect in this season.

Table-2: Details about Pre Season Paddy Cultivation of Sample Respondents who are Experienced with BPH Outbreak during 2018 *Yala* Season from Selected DS Areas of the Ampara District

Variables	Categories	Frequency (N=50)	Percentage (%)
Varieties	3 month	9.0	18.0
	3.5 months	41.0	82.0
Un favorable weather conditions	Yes	30.0	60.0
	No	20.0	40.0
Severe pest problems	Yes	10.0	20.0
	No	40.0	80.0
Severe disease problems	Yes	6.0	12.0
	No	44.0	88.0
Yield (Bushels per acre)	45-60	11.0	22.0
	61-71	26.0	62.0
	71-86	13.0	16.0

General Details of 2018 *Yala* Cultivation

In table 3, out of total respondents, 82% of them cultivated 3.5-month varieties and rest number was to three-month varieties. But when considering the fertilizer application on time basis, 70% of them did not follow the timely recommendation. In same time, water accessibility was only in 26% in considerable level but the majority (74%) of the framers did not obtain the water in needed amount. While coupling these two factors; improper fertilizer application on time and water inaccessibility, it could be caused to alter the physiological status of the crop, which means the imbalance in the growth and development along with the time periods. It might be led to destruct the immune systems of crop and this prevailed condition brought the space for the BPH attack. In this season, about 56% of the respondents highlighted the attack of thrips in their field during early stage of cultivation. To control the thrips 94% of the respondents revealed that they completely allowed the chemical usage.

Teo 2011 indicated that spraying of insecticide in rice field for controlling other pests destroys essential ecosystem services that regulate invading BPH adults,

thus increasing the risk of hopper burn on the field [11]. Bottrell and Schoenly 2012 reported that the sublethal insecticide applications could theoretically increase BPH's capacity for migration because the BPH would acquire more fat and sugar, which provide fuel for flight, when feeding on insecticide-treated rice plants than when feeding on untreated plants [12]. By considering these findings, the pesticides applied to control thrips attack during the season might be one of the reasons for the BPH upsurge.

Table-3: General Details about Paddy Cultivation of Sample Respondents from first Day after Sowing (DAS) to the Date of BPH Outbreak Observed during 2018 *Yala* Season from Selected DS Areas of the Ampara District

Variables	Categories	Frequency (N=50)	Percentage
Varieties	3 month	9.0	18.0
	3.5 months	41.0	82.0
Fertilizer application on time	Yes	15.0	30.00
	No	35.0	70.00
Water accessibility	Yes	13.0	26.00
	No	37.0	74.00
Pest during early stage of cultivation other than BPH	Yes	28.0	56.0
	No	22.0	44.0
Control measures adopted for such pests	Cultural method	3.0	6.0
	Chemical method	47.0	94.0
	Biological method	0.0	0.0

Details about BPH Outbreak, Control Measures Adopted and Its Mechanisms

In BPH infestation, the observation of correct symptoms becomes more important than the control measures adopt. Most of the sampled farmers (80%) started to observe the damage symptoms between 46 to 66 days after sowing of the paddy. At the early stages of the feeding, no apparent changes in host plant meanwhile in heavy infestation only can observe yellowing and hopper burn [13]. Further, it was revealed that the yellowing was observed by 40% of the respondents meanwhile lodging and hopper burn were observed by 60% of the respondents as the maximum level of symptom. As far as concern the control measures adopted by the farmers, about 88% of the respondents used chemical method meantime most of them (68%) were used chemicals at more than recommended dosage to control further infestation in their fields during this outbreak. Further, chi square test revealed that there were significant association between severity of the symptoms observed and the dosage of chemicals used by the farmers (p=0.000) based on the data obtained at the present survey.

Sample respondents specified that it was not possible to be grown paddy without applying pesticides because of the intensity of the BPH at outbreak do not show the reduction to other control measures. As per the survey, majority of the farmers (56%) used Carbosulfan 20 SC+ Sulfloxyflor 50% WG (Transform ^{TM}) to control the BPH. Other chemical combinations such as Imidaclobrid 70% WG +Sulfloxyflor 50% WG and Ethiprole 10 SC+ Sulfloxyflor 50% WG were recorded 24% and 8%, respectively used by the famers to overcome from the BPH outbreak. The study further revealed that during the outbreak time, famers selected different types of chemicals which perform on different mode of actions. Carbosulfan 20 SC (IA carbamates) has the nerve action [14] as it contains Acetylcholinesterase inhibitors in meantime Imidaclobrid 70% WG (4A Neonicotinoids) has the nerve action but it is a Nicotinic acetylcholine receptor competitive modulators [15]. In case of sulfoxaflor 50% WG (4C Sulfoximines) has the nerve action but it has the distinct function than Neonicotinoids. Because Sulfoximines is targeting piercing and sucking mouth part insects such as BPH, due to this chemical structures and different binding to receptor sites in nerve impulse, enzymes which metabolize neonicotinoids do not metabolize sulfoximines. Spark and Nauen 2015 stated that insecticide resistant plays a major role in the controlling of insect pest more than half a century [16]. In this present survey, about 88% of the sampled farmers were applied combination of one chemical only with sulfoxaflor 50% WG by its different ability in lethal action. It is further confirmed that the controlling of pest in outbreak time period could be achieved by selecting pesticides those have different mode of action until find the suitable one for minimizing the outbreak. Das 2013 reported that pest resistant is avoided by rotating the chemicals that work through different modes of action [17].

Table-4: Details of BPH Outbreak of Sample Respondents during Yala Season in 2018 from Selected DS Areas of the Ampara District

Variables	Categories	Frequency (N=50)	Percentage (%)
On which date farmers observed at least one of the symptoms of BPH outbreak	25-45 DAS	8.0	16.0
	46-66 DAS	40.0	80.0
	67-87 DAS	2.0	4.0
Maximum symptoms observed	Yellowing	20.0	40.0
	Lodging and hopper burn	30.0	60.0
Control measures used	Cultural method	6.0	12.0
	Chemical method	44.0	88.0
	Biological method	0.0	0.0
Dosage of Chemicals used	Recommended rate	16.0	32.0
	More than recommended date	34.0	68.0
Type of Chemicals used	Carbosulfan 20 SC+ Sulfloxyflor 50% WG	28.0	56.0
	Carbosulfan 20 SC +Sulfloxyflor 50% WG	12.0	24.0
	Imidaclobrid 70% WG+Carbosulfan 20 SC	3.0	6.0
	Ethiprole 10 SC+ Sulfloxyflor 50% WG	4.0	8.0
	Other chemical combinations	3.0	6.0
Selection of chemicals were made based on the mode of action	Yes	44.0	88.0
	No	06.0	12.0
Extension services received	Satisfied	45.0	90.0
	Not satisfied	5.0	10.0
	45-60	26.0	56.0
Net Yield (Bushels per acre)	61-71	18.0	36.0
	71-86	4.0	8.0

Due to this outbreak of BPH, about 36% of the respondents were obtained the yield in the range of 61 to 71 bushels per acre. However, 56% of the respondents were obtained lower net yield, 45 to 60 bushels per acre. In addition to that, it was reported that the cost of production was higher and to certain number of famers, they just covered up only the production cost through net yield. Farmers also indicated that yield loss increased with variability in the weather conditions and the local agro-ecological conditions. This might be induced the BPH outbreak. The success rate of application and control measures depend on the knowledge and skills sharing among the farmers. Fortunately, the extension services provided by the Department of Agriculture during this outbreak period was at satisfactory level up to 90%.

CONCLUSIONS

Therefore, it could be concluded that the controlling of BPH during outbreak could be achieved by choosing pesticides those have completely different mode of action till realize the acceptable one for minimizing the effects. Further, combination of pesticides which has the active ingredient of sulfoxyflor 50% WG (4C Sulfoximines) would be the best solution for controlling BPH outbreak out of available chemicals in the market.

REFERENCES

1 Department of Agriculture. Rice cultivation. 2018. Available online: https://doa.gov.lk/rrdi/index.php?option=com_sppagebuilder&view=page&id=42&lang=en. Accessed on 31st October, 2018.

2 Senanayake SM, Premaratne SP. An analysis of the paddy/rice value chains in Sri Lanka. Australia South Asia Research Centre working paper. 2016 Jul 1;4.

3 Department of census and statistics. 2018. Available Online: http://www.statistics.gov.lk/PressReleases/Files/en/PSY_20180222E.pdf. Accessed on 31st October, 2018.

4 Wu SF, Zeng B, Zheng C , Mu XC , Zhang Y , Hu J, Shen JL. The evolution of insecticide resistance in the brown planthopper (Nilaparvata lugens Stål) of China in the period 2012–2016. Scientific reports. 2018; 8(1): 4586.

5 Brown Planthopper (BPH) *Nilaparavata lugens* (Stal). Available from http://www.rkmp.co.in/sites/default/files/eis_states/Brown%20Planthopper%20_BPH.pdf

6 Assessing BPH outbreak risks of commonly used insecticides. Available from http://ricehoppers.net/2010/09/farmers-in-central-thailand-remaintrapped-by-the-bph-problem/

7 Farms that apply insecticides for leaf folder control are 10 times more at risk to hopperburn. Available from http://ricehoppers.net/ 2009/09/farms-that -apply-insecticides-for-leaf-folder-control-are-10-timesmore-at-risk-to-hopperburn/

8 Rice plant hopper outbreaks in Bangladesh. Available from http://ricehoppers.

net/2009/08/rice-planthopper-outbreaks-in-bangladesh/ planthopper-outbreaks-in-2009

9 Plant hopper outbreaks in 2009. Available from http://ricehoppers. net/2009/09/.

10 Dyck VA, Misra BC, Alam S, Chen CN, Hsieh CY, Rejesus RS. Ecology of the brown planthopper in the tropics: Brown plant hopper: threat to rice production in Asia, International Rice Research Institute, Los Banos, Laguna, Philippines, 1979; 61-98.

11 Insecticide abuse in rice production causes planthopper outbreaks. Available from https://www.asianscientist.com/2011/12/topnews/iri-ban-insecticides-rice-production-due-to-planthopper-outbreaks-2011/

12 Bottrell DG, Schoenly KG. Resurrecting the ghost of green revolutions past: The brown planthopper as a recurring threat to high-yielding rice production in tropical Asia. Journal of Asia-Pacific Entomology. 2012; 15: 122–140.

13 Sogawa K, Cheng CH. Economic thresholds, nature of damage, and losses caused by the brown planthopper, in Brown Planthopper: Threat to Rice Production in Asia. The International Rice Research Institute; Los Banos, Laguna, Philippines. 1979; 125–142.

14 Nakayama A, Sukekawa M. Quantitative correlation between molecular similarity and receptor-binding activity of neonicotinoid insecticides. Pesticide Science. 1998; 52: 104-110.

15 Eldefrawi ME, Eldefrawi AT. Nervous-system-based insecticides: Safer Insecticides: Development and Use. Hodgson, Kuhr RJ editors, Marcel Dekker, New York. 1990; 155-207.

16 Sparks TC, Nauen R. IRAC. Mode of action classification and insecticide resistance management. Pesticide Biochemistry and Physiology. 2015; 121:122–128.

17 Das SK. Mode of action of pesticides and the novel trends–A critical review. International Research Journal. 2013; 393-401.