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Population Dynamics of Insect Pest Complex under Rice Field Ecosystem of Eastern Uttar Pradesh, India

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ABSTRACT: Rice insect pests are major constraint in rice production. The insect pests of rice infest all parts of the plant at all growth stages and transmit few viral diseases of rice. Rice is grown mostly under Indo-Gangetic plains zone of India, which is widely distributed in Uttar Pradesh. This zone is mostly a warm humid environment conductive to the survival and proliferation of arthropods biodiversity. A study was undertaken to surveillance of population dynamics of insect pest complex under rice field ecosystem of Eastern Uttar Pradesh, India for two consecutive years, 2014 and 2015 in rainy season (Kharif). The surveillance was conducted in 03 administrative divisions namely, Gorakhpur, Basti and Azamgarh. There were 38 insect pest species observed under 03 rice growth stages of seedling, transplanting and flowering. The test of significance was used analysis of variance in randomized block design (RBD). Of the total observed test of significance under the population of rice insect pest complex, the differences between the means of damaging groups of insect pests and growth stages of rice were inferenced significant, while the difference between the means of administrative divisions was inferenced not significant. The standard deviations for both damaging groups of insect pests and growth stages of rice was 73.71 and damaging groups of insect pests with growth stages of rice was 1516.62 respectively. The coefficient variations for both damaging groups of insect pests and growth stages of rice was 2.53 % and damaging groups of insect pests with growth stages of rice was 52.13 % respectively. Surveillance was conducted as per methodology of agroecosystem analysis (AESA) (Pontius *et al.*, 2002) modified as accessibility.

Keywords: Population dynamics, Rice insect pest complex, Eastern Uttar Pradesh, India.

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INTRODUCTION

Rice is a staple food for 70% population over the world and 65% population of the India. It is grown in almost all the states of India and shares 21% of the world rice production. Uttar Pradesh shares 15% of the India rice production and occupies second position after West Bengal (17%) and first position in rice crop area. Despite this above proud credentials, Uttar Pradesh is not appearing leading position. The main cause of low productivity is traditional and ill cultivation practices by losses 65% of yield of the highest productivity and shares 25% losses caused by insect pests itself. To fill this productivity gap, the responsibility of Uttar Pradesh has become more, when it has occupied first position in rice crop area (Pathak and Khan, 1994; Maclean *et al*., 2002; Viraktamath, 2013; Dhaliwal *et al*., 2015; Heinrichs and Muniappan, 2017; DAC&FW, 2018).

Rice is grown under different agroclimatic zones of India and distributed over 15 zones. Rice is grown mostly under Indo-Gangetic plains zone of India, which is widely distributed in Uttar Pradesh. The zone is mostly a warm humid environment conductive to the survival and proliferation of arthropods biodiversity. About 800 insect pest species associated with rice crop over world. Among them 250 insect pest species associated with rice crop in India and 20 of them are pests of major economic significance. There are 38 insect pest species of rice recorded in Eastern Uttar Pradesh conditions. The insect pests of rice infest all parts of the plant at all growth stages and transmit few viral diseases of rice. At national level, stem borers accounted for 30% yield loss, while plant hoppers (20%), gall midge (15%), leaf folders (10%) and other pests (25%), respectively (Pathak and Khan, 1994; Shepard, Barrion and Litsinger, 1995; David and Ananthakrishnan, 2004; Prakash *et al*., 2014; Morya *et al.*, 2015; Heinrichs and Muniappan, 2017; Krishnaiah and Varma, 2018).

Litsinger *et al.,* (1987) has been reported that, the damage during vegetative phase (50%) contributed more to yield reduction than reproductive phase (30%) and ripening phase (20%) in rice due to insect pests. Parasappa *et al.,* (2017) has been found that, the yellow stem borer caused dead hearts during vegetative stage and white ears at harvest.

Among the sucking pests, the population of green leafhoppers was found throughout the crop growth. The population of defoliators, rice skipper, and rice horned caterpillar were active at the tillering stage of the crop and declined with the advancement of the crop stage. Sulagitti *et al.,* (2017) has also been reported that, the incidence of yellow stemborer, leaf folder and brown planthopper were observed highest in vegetative phase, while the rice earhead bug was observed highest infestation at reproductive phase.

MATERIALS AND METHODS

The surveillance of population dynamics of rice insect pests complex was studied under rice fields of Eastern Uttar Pradesh conditions for two consecutive years, 2014 and 2015 respectively. The observation was recorded under 03 growth stages of rice, *i.e.*, seedling, transplanting, and flowering in all 10 districts of 03 administrative divisions of Eastern Uttar Pradesh, *i.e*., Gorakhpur (Gorakhpur, Deoria, Kushinagar, and Maharajganj), Basti (Basti, Santkabirnagar, and Siddharthnagar) and Azamgarh (Azamgarh, Mau, and Ballia). The observation of samples was recorded randomly for concerned districts of all 03 divisions for each growth stage of rice for two years consecutively. There was each field selected for each division, growing stage and year. There were five samples collected per field at the plot size of 100 m^2. Therefore, during the entire crop period a total of 90 samples (3 × 3 = 9 × 5 = 45 × 2= 90) collected from 3 divisions for consecutive two years respectively. All 90 samples were converted average total of 18 samples (3 × 3= 9 × 2= 18) of all 03 divisions for two years. Samples were taken 03 times at interval of 20 days after sowing (20 DAS) for seedling stage, 30 days after transplanting (30 DAT) for transplanting stage and 60 DAT for flowering stage respectively. Each plot was selected 5 spots (4 in the corner at least 60 cm inside the border and one in the centre) to collect samples at 0.25m^2/spot for seedling stage and at 01 hill/spot for transplanting and flowering stage to observe abundance of insect pests and their infestation. There were five net sweeps made randomly at every five steps at each plot to observe population of insect pest complex for all 03 growth stages of rice. The sweeping net size was 25 cm diameter and 70 cm handle and made up of nylon. The sampling was taken between timing of 9.30 A.M. to 12.30 P.M. Surveillance was conducted as per methodology of agroecosystem analysis (AESA) (Pontius *et al*., 2002) modified as accessibility. The inferences of population dynamics were calculated for mean, standard deviation, coefficient of variation and test of significance. The test of significance was used analysis of variance in randomized block design (RBD) for damaging groups of insect pests, growth stages of rice, and damaging groups with growth stages of rice among all 3 administrative divisions.

The identification of insect pests was verified with texts of reference, *i.e*., Dale (1994), Barrion and Litsinger (1994), Pathak and Khan (1994), David and Ananthakrishnan (2004); Rice knowledge management portal (RKMP); and Subject experts respectively. The inferential calculations were verified with texts of reference, *i.e*., Dhamu and Ramamoorthy (2007); Rangaswamy (2010).

RESULTS AND DISCUSSION

There were 38 insect pest species observed for sum of both the years 2014 and 2015, comprise of 4 damaging groups (stem borers, leaf hoppers, sap feeders, and root feeders) under 3 rice growth stages (seedling, transplanting, and flowering). The damaging groups were comprised insect pest species as, the stem borers for 6 species, the leaf feeders for 13 species, the sap feeders for 11 species, and the root feeders for 8 species respectively. The number and percentage of population of rice insect pest complex for consecutive years and sum of both the years 2014 and 2015 were observed respectively. Of the total observed population of insect pest complex (8728) for sum of both the years 2014 and 2015, there were 885(10.13%), 3442(39.43%), 4327(49.57%), and 74(0.84%) for stem borers, leaf feeders, sap feeders, and root feeders; 2896(32.37%), 2936(33.63%), and 2966(33.98%) for Gorakhpur, Basti, and Azamgarh; and 4506(51.62%), 2734(31.32%), and 1488(17.04%) for seedling stage, transplanting stage, and flowering stage respectively. Of the total observed population of insect pest complex for sum of both the years 2014 and 2015, the rankings were sap feeders > leaf feeders > stem borers > root feeders for damaging groups of insect pests; seedling stage > transplanting stage > flowering stage for growth stages of rice; and Azamgarh > Basti > Gorakhpur for administrative divisions of Eastern Uttar Pradesh respectively. The rankings of damaging groups with growth stages of rice were leaf feeders > sap feeders > stem borers > root feeders in seedling stage; and sap feeders > stem borers > leaf feeders > root feeders in transplanting stage, flowering stage, and total for all growth stages of rice respectively (Table & Fig. 1).

Table 1: Rank Population of Rice Insect Pest Complex (Sum of 2014 & 2015).

Population of Rice Insect Pest Complex					
Different Damaging Groups		**Different Growth Stages of Rice**		**Different Administrative Divisions**	
Damaging Groups	Population (%)	Growth Stages	Population (%)	Administrative Divisions	Population (%)
1. Sap feeders	49.57	1. Seedling	51.62	1. Azamgarh	33.98
2. Leaf feeders	39.43	2. Transplanting	31.32	2. Basti	33.63
3. Stem borers	10.13	3. Flowering	17.04	3. Gorakhpur	32.37
4. Root feeders	0.84	—	—	—	—

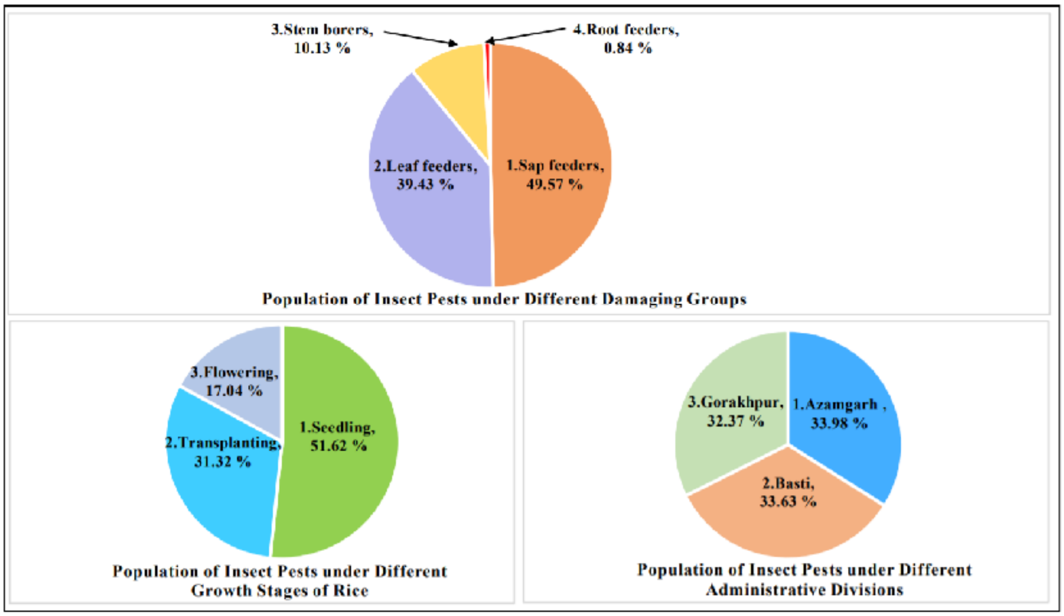

Fig. 1. Rank Population of Rice Insect Pest Complex (Sum of 2014 & 2015).

The test of significance was inferenced under the population of rice insect pest complex for sum of both the years 2014 and 2015. The test of significance was used analysis of variance in randomized block design (RBD) for damaging groups of insect pests, growth stages of rice, and damaging groups with growth stages of rice among all 3 administrative divisions. Of the total observed test of significance under the population of rice insect pest complex for sum of both the years 2014 and 2015, the differences between the means of damaging groups of insect pests and growth stages of rice were inferenced significant, while the difference between the means of administrative divisions was inferenced not significant respectively. The difference between the means of damaging groups of insect pests with growth stages of rice was inferenced not significant for both the damaging groups of insect pests and growth stages of rice. The standard deviation (S.D.) and coefficient of variation (C.V.) were analysed for damaging groups of insect pests, growth stages of rice, and damaging groups with growth stages of rice under the population of rice insect pest complex for sum of both the years 2014 and 2015 respectively. Of the total observed standard deviations under the population of rice insect pest complex for sum of both the years 2014 and 2015, the standard deviations for both damaging groups of insect pests and growth stages of rice was 73.71 and damaging groups of insect pests with growth stages of rice was 1516.62 respectively. Of the total observed coefficient variations under the population of rice insect pest complex for sum of both the years 2014 and 2015, the coefficient variations for both damaging groups of insect pests and growth stages of rice was 2.53 % and damaging groups of insect pests with growth stages of rice was 52.13 % respectively (Table 2a, b & c).

Table 2a: Population Inference for Different Damaging Groups (Sum of 2014 & 2015).

Observation Years	Damaging Groups	Administrative Divisions of Eastern Uttar Pradesh (India)							
		Number				Inference			
		Gorakhpur	Basti	Azamgarh	Total	Mean	S.D.	C.V.	P-value (RBD)
2014 and 2015	Stem borers	196	388	301	885	295.00	96.14	32.59	Damaging Groups (P < 5%)
	Leaf feeders	1075	1247	1120	3442	1147.33	89.20	7.77	
	Sap feeders	1526	1285	1516	4327	1442.33	136.35	9.45	
	Root feeders	29	16	29	74	24.67	7.51	30.43	Administrative Divisions (P > 5%)
	Total	**2826**	**2936**	**2966**	**8728**	**2909.33**	**73.71**	**2.53**	—

Table 2b: Population Inference for Different Growth Stages of Rice (Sum of 2014 & 2015).

Observation Years	Growth Stages of Rice	Administrative Divisions of Eastern Uttar Pradesh (India)							
		Number				Inference			
		Gorakhpur	Basti	Azamgarh	Total	Mean	S.D.	C.V.	P-value (RBD)
2014 and 2015	Seedling	1354	1595	1557	4506	1502.00	129.57	8.63	Growth Stages (P < 5%) Administrative Divisions (P > 5%)
	Transplanting	890	970	874	**2734**	911.33	51.43	5.64	
	Flowering	582	371	535	**1488**	496.00	110.77	22.33	
	Total	**2826**	**2936**	**2966**	**8728**	**2909.33**	**73.71**	**2.53**	—

Table 2c: Population Inference for Damaging Groups & Growth Stages (Sum of 2014 & 2015).

Observation Years	Damaging Groups	Growth Stages of Rice							
		Number				Inference			
		Seedling	Transplanting	Flowering	Total	Mean	S.D.	C.V.	P-value (RBD)
2014 and 2015	Stem borers	168	384	333	885	295.00	112.90	38.27	Growth Stages (P > 5%) Damaging Groups (P > 5%)
	Leaf feeders	3097	298	47	3442	1147.33	1693.12	147.57	
	Sap feeders	1198	2042	1087	**4327**	1442.33	522.28	36.21	
	Root feeders	43	10	21	**74**	24.67	16.80	68.12	
	Total	**4506**	**2734**	**1488**	**8728**	**2909.33**	**1516.62**	**52.13**	—

CONCLUSION

The significant variation among damaging groups and growth stages of rice were followed the natural phenomenon of variation, while non-significant variation among administrative divisions were represented the similar ecosystem of confined area of study. The significant variation among damaging groups and growth stages of rice under observed administrative divisions reflects the particular management strategy for particular source of significant variation, while the non-significant variation among administrative divisions solely reflects the universal management strategy for all sources of variation. Similar findings have been reported by Chakraborty and Deb (2012); Gangwar *et al.*, (2015); Saini *et al*., (2015); Parasappa *et al.*, (2017); Dwivedi (2018).

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