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Population Dynamics of Bioagent Complex Under Rice Field Ecosystem of Eastern Uttar Pradesh, India

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ABSTRACT: Rice is the most important staple food for more than half population of the India and world. 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. Insect pests are major constraints in rice production. Bioagents have been playing potential role in ecofriendly insect pest management. A study was undertaken to surveillance of population dynamics of bioagent 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 41 bioagent 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 bioagent complex, the differences between the means of both most bioagent groups and all 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 most bioagent groups and growth stages of rice was 7.81 and most bioagent groups with growth stages of rice was 642.00 respectively. The coefficient variations for both most bioagent groups and growth stages of rice was 1.22 % and most bioagent groups with growth stages of rice was 30.34 % respectively. Surveillance was conducted as per methodology of agroecosystem analysis (AESA) (Pontius *et al*., 2002) modified as accessibility. The identification of insect pests complex 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.

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

INTRODUCTION

Rice is the most important staple food for more than half population of the India and world. More than 110 countries grow rice on one fifth of the world food grain crop area. Rice shares 27 % of the world food grain production and occupies second position after wheat and 56 % of the India food grain production and occupies first position. India shares 21 % of the world rice production and occupies second position after China. Uttar Pradesh shares 15 % of the India rice production occupies second position followed by West Bengal (17%) and first in rice production area. Despite these above proud credentials, Uttar Pradesh is not appearing leading position. The main cause of low productivity of rice is ill cultivation practices and crop losses. The crop losses share about 32.1% losses by plant ailments and among them, about 10.8% losses caused by pests globally and India have been reported about 17.5% losses caused by insect pests. India have been estimated rice crop losses by insect pests ranging from 21 to 51 %. (Pathak and Khan, 1994; Maclean *et al*., 2002; Oerke, 2006; Viraktamath, 2013; Dhaliwal *et al*., 2015; Heinrichs and Muniappan, 2017; DAC&FW, 2018; Morya and Kumar, 2019).

Bioagents are natural enemies, which attack various life stages of insects to kill as a prey or host to complete their life cycle. They are silent suppression factors of insect pests in rice ecosystem. Predators and parasitoids are varying in feeding and egg laying potential, which have been playing significant role in ecofriendly insect pest management. About 550 arthropod bioagent species associated with rice insect pests in India. There were also 32 species of larval and 08 species of pupal parasitoids reported for rice field in India. There have been 20 species of arthropod bioagents recognized as major economic significance. There are 41 bioagent species of rice insect pests recorded in Eastern Uttar Pradesh conditions. (Pathak and Khan, 1994; Ooi and Shepard, 1994; David and Ananthakrishnan, 2004; Prakash *et al*., 2014; Fahad *et al*., 2015; Heinrichs and Muniappan, 2017; Morya and Kumar, 2017).

Gangurde *et al.* (2007) have been reported that, the predator : pest ratio during the seedling was zero indicating no appearance of pest and predator species, while during the tillering stage of the crop, the ratio was calculated 1:1, which is also expected as balanced ecosystem and when the pest population developed, the predator population soon became abundant. Parasappa *et al.* (2017) have also been reported that, among the predators, the spiders and mirids were the most important natural enemies. Spiders and odonates recorded as general predators of rice insect pests. The spiders, dragonfly, damselfly, and coccinellids were more during the vegetative stage of the crop, whereas mirids, staphylids, and cicindelids were more during reproductive stage of the crop.

MATERIALS AND METHODS

The bioagent complex of rice insect pests were observed under rice fields of Eastern Uttar Pradesh conditions for two consecutive years (2014 and 2015) to surveillance their population dynamics. The observation was surveyed 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) under 03 growth stages of rice, *i.e.,* seedling, transplanting, and flowering. The samples were taken randomly for concerned districts of all 03 divisions for each growth stage of rice for consecutively two years. There was each field selected at each division per growing stages for each year. There were 5 samples collected per field at the plot size of 100 m^2. Therefore, during the entire crop period a total of 90 samples (3X3 = 9X5= 45X2= 90) collected from 3 divisions for consecutive two years respectively. All 90 samples were converted average total of 18 samples (3X3= 9X2= 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 bioagent population. There were 05 net sweeps made randomly at every 05 steps at each plot to observe abundance of bioagent population for all 03 growth stages of rice. The size of sweep net were 25 cm diameter and 70 cm handle and made up of nylon. The timing of sampling was taken between 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 bioagent groups, growth stages of rice, and bioagent groups with growth stages of rice among all 3 administrative divisions.

The identification of insect pests was verified with texts of reference, *i.e*., 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 41 bioagent species observed for sum of both the years 2014 and 2015, comprise of 13 bioagent groups (spiders, coccinellids, cicindelids, carabids, odonates, orthopterans, mantids, mirids, staphylids, dermapterans, neuropterans, dipterans, and hymenopterans) under 3 rice growth stages (seedling, transplanting, and flowering). The groups of bioagent species were also grouped into two most bioagent groups, namely predators (spiders, coccinellids, cicindelids, carabids, odonates, orthopterans, mantids, mirids, staphylids, dermapterans, and neuropterans) and parasitoids (dipterans and hymenopterans) 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 bioagent complex (1926) for sum of both the years 2014 and 2015, there were 1687(87.59%) and for predators and parasitoids; and 430(22.32%), 813(42.21%), and 683(35.46%) for seedling stage, transplanting stage, and flowering stage; 646(33.54%), 647(33.59%), and 633(33.98%) for Gorakhpur, Basti, and Azamgarh respectively. Of the total observed population of bioagents for sum of both the years 2014 and 2015, the rankings were parasitoids > predators for most bioagent groups; flowering stage > transplanting stage > seedling stage for growth stages of rice; and Basti > Gorakhpur > Azamgarh for administrative divisions of Eastern Uttar Pradesh respectively. Of the total observed population of bioagents for sum of both the years 2014 and 2015, the rankings of most bioagent groups were parasitoids > predators for total of all growth stages of rice (Table & Fig. 1).

The test of significance was inferenced under the population of bioagent 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 growth stages of rice, most bioagent groups, and most bioagent groups with growth stages of rice among all 3 administrative divisions. Of the total observed test of significance under the population of bioagents for sum of both the years 2014 and 2015, the differences between the means of both most bioagent groups and all 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 most bioagent groups with all growth stages of rice was inferenced not significant for growth stages of rice and significant for most bioagent groups 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 most bioagent groups, growth stages of rice, and most bioagent groups with growth stages of rice under the population of bioagent 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 most bioagent groups and growth stages of rice was 7.81 and most bioagent groups with growth stages of rice was 642.00 respectively. Of the total observed coefficient variations under the population of bioagent complex for sum of both the years 2014 and 2015, the coefficient variations for both most bioagent groups and growth stages of rice was 1.22 % and most bioagent groups with growth stages of rice was 30.34 % respectively (Table-2a, b & c).

Table 1: Rank Population of Bioagent Complex (Sum of 2014 & 2015).

Population of Bioagent Complex					
Different Bioagent Groups		**Different Growth Stages of Rice**		**Different Administrative Divisions**	
Bioagent Groups	Population (%)	Growth Stages	Population (%)	Administrative Divisions	Population (%)
1. Predators	87.59	1. Transplanting	42.21	1.Basti	33.59
2. Parasitoids	12.41	2. Flowering	35.46	2. Gorakhpur	33.54
—	—	3. Seedling	22.32	3. Azamgarh	32.86

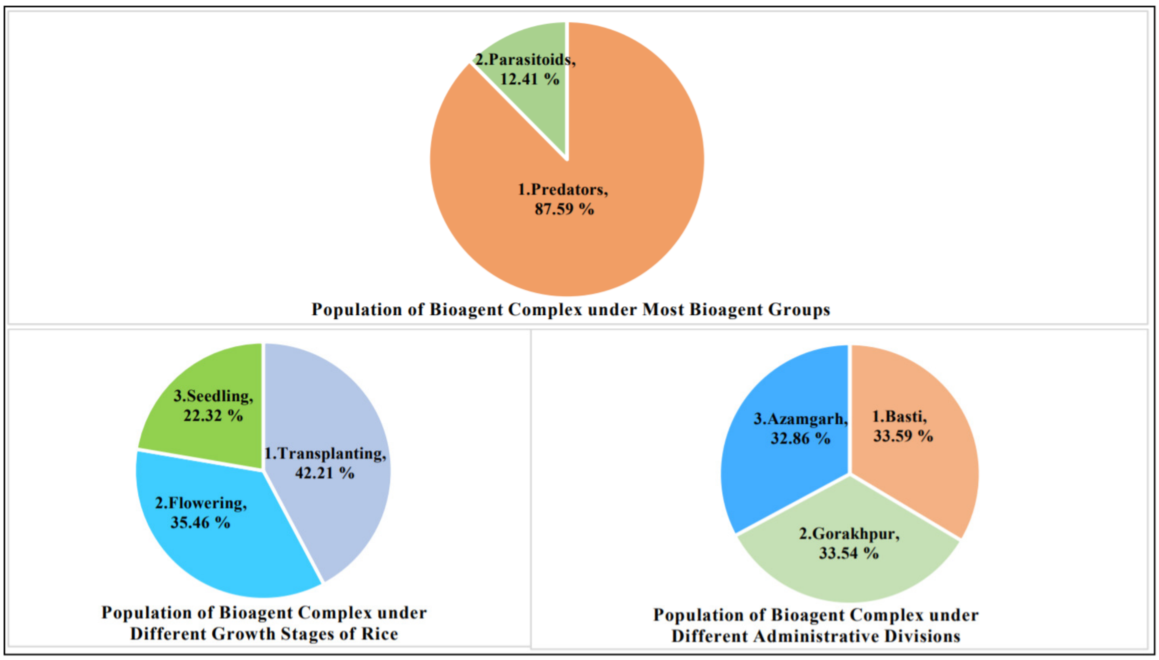

Fig. 1. Rank Population of Bioagent Complex (Sum of 2014 & 2015).

Table 2a: Bioagents Population Inference for 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	140	148	142	430	143.33	4.16	2.90	Administrative Divisions (P > 5%) Growth Stages (P < 5%)
	Transplanting	274	273	266	**813**	271.00	4.36	1.61	
	Flowering	232	226	225	**683**	227.67	3.79	1.66	
	Total	**646**	**647**	**633**	**1926**	**642.00**	**7.81**	**1.22**	—

Table 2b: Bioagents Population Inference for Most Bioagent Groups (Sum of 2014 & 2015).

Observation Years	Most Bioagent 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	Predators	568	565	554	1687	562.33	7.37	1.31	Administrative Divisions (P > 5%) Bioagent Groups (P < 5%)
	Parasitoids	78	82	79	**239**	79.67	2.08	2.61	
	Total	**646**	**647**	**633**	**1926**	**642.00**	**7.81**	**1.22**	—

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

Observation Years	Most Bioagent Groups	Growth Stages of Rice							
		Number				Inference			
		Seedling	Transplanting	Flowering	Total	Mean	S.D.	C.V.	P-value (RBD)
2014 and 2015	Predators	380	705	602	1687	562.33	166.09	29.54	Growth Stages (P > 5%) Bioagent Groups (P < 5%)
	Parasitoids	50	108	81	239	79.67	29.02	36.43	
	Total	**430**	**813**	**683**	**1926**	**642.00**	**642.00**	**30.34**	—

CONCLUSION

The significant variation among most bioagent 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 most bioagent 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 Ooi and Shepard (1994); Bhattacharyya *et al.,* (2006); Gangurde *et al.,* (2007); Fahad *et al.*, (2015); Chakraborty *et al.*, (2016); Heinrichs and Muniappan, (2017); Parasappa *et al.,* (2017); Krishnaiah and Varma (2018).

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