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INFLUENCE OF WEATHER ON THE PARASITOID CATCHES IN THREE RICE GROWING AGROCLIMATIC ZONES OF TAMIL NADU

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ABSTRACT

Parasitic hymenopterans play a vital role against many pests of rice regulating them naturally. The present study evaluated the influence of weather factors on such parasitic hymenopterans in rice under three agroclimatic rice zones of Tamil Nadu viz., western, Cauvery delta and high rainfall zones during 2015-16. Collections were made for 20 consecutive days in each zone. The weather data viz., maximum temperature, minimum temperature, relative humidity and rainfall were used correlated with the parasitoid population. These revealed significantly negative correlation with maximum temperature and a positive one with minimum temperature, relative humidity and rainfall in the Cauvery delta zone. In the high rainfall zone, the parasitoid population exhibited positive and significant correlation with rainfall and positive but non-significant correlation with maximum temperature and relative humidity, and negative non-significant correlation with that of minimum temperature. The parasitoid population showed non-significant negative correlation with temperature (maximum and minimum), relative humidity and rainfall in the western zone.

Key words: Rice ecosystem, agroclimatic zones, Tamil Nadu, parasitoids, rainfall, temperature, Tamil Nadu, correlation, population dynamics

Rice (*Oryza sativa* L.) crop is the traditional landscape in rural environments and a key ecosystem of Asia (Kiritani, 2009). Tamil Nadu, one of the leading rice growing states in India, has been cultivating rice from time immemorial. Rice fields harbour a rich and varied fauna than any other agricultural crop (Heckman, 1979; Fritz et al., 2011). Cornell and Hawkins (1995) opined that meteorological factors might affect insect pest populations directly through influences on reproductive and mortality ratios, and indirectly, through influences on their parasitoids. Seasonal variation in weather, such as rainfall and temperature maxima and minima, might cause dramatic changes in abundance of parasitic hymenopterans, especially in temperate ecosystems. Guedes et al. (2000) revealed that weather factors influenced food availability, parasitoids and herbivorous populations and, therefore, could be important determinants of fluctuation of insect- pest populations. Food available to insect pest in particular gets influenced by weather factors and thereby it influences the population build up of parasitoids as well.

The weather factors affect insect population dynamics via faster developmental rates with increasing temperature, and lower survival with heavy rain, extreme temperatures and low moisture (Hespenheide, 1991; Nestel et al., 1994; Tipping et al., 2005), and by negatively affecting individual reproductive behaviour (Wang et al., 1997; Saethre and Hofsvang, 2002). Similarly, meteorological factors might influence the mortality ratios caused by parasitic hymenopterans (Weisser et al., 1997; Stireman et al., 2005). The hymenopterans show maximum abundance in spring and summer, lower abundance in autumn, and the least abundance in winter in rice fields in the town of Rio Grande, in Rio Grande do Sul state (Oliveira et al., 2009); Ichneumonidae and Braconidae were the most common parasitoid families with 70% correlation between temperature and abundance while no correlation was found with rainfall. Refugio et al. (2010) concluded that understanding the impacts of local weather variables on insect population dynamics is essential for the sustainability of any agroecosystem. Since, the parasitic hymenopterans play a vital role in checking excessive increase of many pests of rice, the present study investigates the influence of weather factors on them.

MATERIALS AND METHODS

The survey was carried out in the rice fields during 2015-16 in three different agroclimatic zones of Tamil Nadu viz., western zone (District representation: Coimbatore at, Paddy Breeding Station, Coimbatore), Cauvery delta zone (District representation: Thiruvarur at, Krishi Vigyan Kendra, Needamangalam) and high rainfall zone (District representation: Kanyakumari at Agricultural Research Station, Thirupathisaram). Collections were made for 20 consecutive days in each zone to give equal weightage and to minimize chances of variations in collection. The time of sampling in each zone was decided by the rice growing season of the zone and the stage of the crop i.e., 20 days during August- September, 2015 in western zone, October- November, 2015 in high rainfall zone and December, 2015- January 2016, in Cauvery delta zone. A total of three gadgets viz., sweep net, yellow pan trap kept at ground level, yellow pan trap erected at canopy levels, were employed for the collection of parasitoids, with all deployed continuously for 20 days

The net employed was essentially an ordinary insect net with 673 mm mouth dia and a 1076 mm long aluminum handle. The frame can be fitted to one end of the handle, facilitating easy separation, and the long handle allows the net to be used as far as possible. The net bag was made up of thin cotton cloth, about 600 mm long with a rounded bottom, and top which fits around the frame made up of canvas. The canvas was folded over the frame and sewed in position. Sweeping of vegetation was as random as possible from ground level to the height of the crop, and done in early morning and late evening for about half an hour/ day which involved 30 sweeps. One to and fro motion of the sweep net was considered as one sweep.

The yellow pan trap was based on the principle that many insects are attracted to bright yellow colour. These are shallow trays of 133 x 195 mm and 48 mm deep, with 20 of these installed at ground level in each site on the bunds, half- filled with water containing a few drops of commercially available detergent (to break the surface tension) and a pinch of salt (to reduce the rate of evaporation and to prevent rotting of trapped insects). The spacing between traps was standardized as 1.5 m. The traps were set for a period of 24 hr (Example: traps set at 10 AM on one day was serviced at 10 AM on the following day). Erected yellow pan traps were installed at the crop canopy by means of polyvinyl chloride pipes fitted below, with a screw attachment @ 10/ site in the same fashion as yellow pan trap kept at ground level.

The weather data viz., maximum and minimum temperature, relative humidity and rainfall for August- September, 2015 for Paddy Breeding Station (Coimbatore), October- November, 2015 for Agricultural Research Station (Thirupathisaram) and December, 2015- January 2016, for Krishi Vigyan Kendra (Needamangalam) were collected from the Agro Climatic Research Centre, TNAU, Coimbatore. These data were used for the computation of correlation coefficients with parasitoids population. The maximum number of parasitoids collected in a period of 20 days in three different rice growing zones of Tamil Nadu was assessed. These statistical analyses were done using Microsoft Excel 2016, with correlation and regression coefficients worked out using SPSS v20 software.

RESULTS AND DISCUSSION

A total of 1349 parasitic hymentopterans were collected from high rainfall zone followed by western zone (1082) and Cauvery delta zone (720). Platygastridae, Ichneumonidae and Braconidae were the most abundant families in all these zones. Apidae, Bethylidae, Dryinidae, Chrysididae, Mutillidae, Scoliidae, Tiphiidae, Ceraphronide, Megaspilidae, Aphelinidae, Chalcididae, Encyrtidae, Eucharitidae, Eulophidae, Eupelmidae, Eurytomidae, Mymaridae, Pteromalidae, Torymidae, Trichogrammatidae, Figitidae, Diapriidae, Evaniidae, Gasteruptiidae and Proctotrupidae were collected. Thus a total of 3151 parasitoids under 28 families and 172 species were collected (Table 1).

The maximum population was observed on 27.12.2015 (74 nos) in Cauvery delta zone, 02.11.2015 (126 nos) in high rainfall zone and 16.08.2015 (103 nos) in the western Zone (Table 2). The regression analyses revealed that the parasitoid population was negatively and significantly correlated with maximum temperature, but positively correlated with minimum temperature, relative humidity and rainfall in the Cauvery delta zone (Table 3); in the high rainfall zone, there existed a positive and significant correlation with rainfall and positive but non significant correlation with maximum temperature and relative humidity and negative non significant correlation with minimum temperature; and a non significant negative correlation with temperature

Table 1. Parasitoids collected from three rice growing zones of Tamil Nadu

Families	Western Zone	Cauvery Delta Zone	High rainfall zone	No. of Individuals	No. of species
Apidae	1	0	0	1	1
Bethylidae	4	2	7	13	2
Dryinidae	2	5	1	8	3
Chrysididae	0	0	1	1	1
Mutillidae	0	0	3	3	2
Scoliidae	1	0	2	3	2
Tiphiidae	3	0	0	3	1
Ceraphronidae	15	11	41	67	2
Megaspilidae	0	0	1	1	1
Aphelinidae	8	1	6	15	3
Chalcididae	21	16	142	179	12
Encyrtidae	2	8	7	17	6
Eucharitidae	0	0	1	1	1
Eulophidae	41	23	97	161	14
Eupelmidae	20	19	42	81	5
Eurytomidae	31	19	67	117	6
Mymaridae	15	41	36	92	6
Pteromalidae	32	21	29	82	13
Torymidae	4	0	6	10	2
Trichogrammatidae	59	27	22	108	2
Figitidae	3	2	6	11	2
Diapriidae	44	21	54	119	6
Evaniidae	13	2	8	23	3
Gasteruptiidae	9	0	0	9	1
Braconidae	180	163	231	574	18
Ichneumonidae	218	159	227	604	33
Proctotrupidae	42	51	24	117	1
Platygastridae	314	129	288	731	22
Total	1082	720	1349	3151	172

Table 2. Population of parasitoids in the three rice growing zones of Tamil Nadu

Days	Western zone		Cauvery Delta zone		High rainfall zone	
	Date	No. of parasitoids collected	Date	No. of parasitoids collected	Date	No. of parasitoids collected
1	16-08-2015	103	26-12-2015	44	23-10-2015	102
2	17-08-2015	38	27-12-2015	74	24-10-2015	89
3	18-08-2015	50	28-12-2015	18	25-10-2015	86
4	19-08-2015	89	29-12-2015	34	26-10-2015	43
5	20-08-2015	45	30-12-2015	54	27-10-2015	43
6	21-08-2015	31	31-12-2015	27	28-10-2015	57
7	22-08-2015	43	01-01-2016	31	29-10-2015	81
8	23-08-2015	41	02-01-2016	54	30-10-2015	88
9	24-08-2015	83	03-01-2016	29	31-10-2015	57
10	25-08-2015	79	04-01-2016	24	01-11-2015	63
11	26-08-2015	78	05-01-2016	59	02-11-2015	126
12	27-08-2015	64	06-01-2016	55	03-11-2015	62
13	28-08-2015	60	07-01-2016	69	04-11-2015	51
14	29-08-2015	24	08-01-2016	45	05-11-2015	70
15	30-08-2015	30	09-01-2016	11	06-11-2015	53
16	31-08-2015	43	10-01-2016	23	07-11-2015	58
17	01-09-2015	36	11-01-2016	19	08-11-2015	76
18	02-09-2015	56	12-01-2016	19	09-11-2015	26
19	03-09-2015	34	13-01-2016	15	10-11-2015	64
20	04-09-2015	55	14-01-2016	16	11-11-2015	54

Table 3. Correlation and regression analysis of parasitoid catches with daily weather parameters

Zones	Constant (A)	Correlation coefficient	X1- Max. Temp (˚C)	X2 - Min. Temp (˚C)	X3 - RH (%)	X4 – RF (mm)	Regression Equation	R^2
Western	261.399	0.251	-5.051	-1.264	-0.139	-0.579	Y = 261.40 - 5.05 X1 - 1.26 X2 - 0.14 X3 - 0.58 X4	0.063
Cauvery delta	201.531	0.641	-6.848	1.117	0.226	0.987	Y = 201.53 - 6.85 X1 + 1.12 X2 + 0.23 X3 + 0.99 X4	0.411
High rainfall	-46.141	0.596	2.405	-3.670	1.230	0.884	Y = -46.14 + 2.41 X1 - 3.67 X2 + 1.23 X3 + 0.88 X4	0.356

(maximum and minimum), relative humidity and rainfall in the western zone.

Rainfall is a key factor to understand the tropical parasitoid activity and community structure (Hurlbert, 1984) and seasonal rainfall pattern is important in influencing fluctuations in parasitoids population (Boinski and Fowler, 1989; Janzen, 1981). The data showed a significant positive correlation of rainfall with parasitoid population in the high rainfall zone (Fig. 1), supporting the hypothesis that abiotic factors are important (Heinrich, 1977; Gauld, 1987). Studies of ichneumonoid activity by Paton (1997) revealed that the population was much higher at La Selva, where 4843 mm of rain fell, than at Panama, which received 1714 mm of rainfall. Parasitoids must search for their hosts in the canopy, thus exposing themselves to more intense desiccation. So, it can be assumed that the desiccation rate will be much reduced where rainfall rate is higher and so their population is increasing.

Table 3 reveals that for every increase in one unit of maximum temperature, the parasitoid population got lowered by 6.85 units, whereas with every increase in one unit of minimum temperature, relative humidity and rainfall, the parasitoid population increased by 1.12, 0.23 and 0.99 unit, respectively in the Cauvery delta zone. Contrarily, in the high rainfall zone, with minimum temperature, it got lowered by 3.67 units; and with regard to maximum temperature, relative humidity and rainfall, it was 2.41, 1.23 and 0.88 units, respectively. In the western zone, for every increase in one unit of temperature (maximum and minimum), relative humidity and rainfall, the parasitoids population reduced by 5.05, 1.26, 0.14 and 0.58 units, respectively.

It is evident from Table 2 that the weather factors contributed 41.1% role in the fluctuation of parasitoid population in Cauvery delta zone; the fluctuation reached up to 35.6% in the high rainfall zone; and only 6.3% variation was observed in the Western Zone. The correlation coefficients given in Table 4 reveal that maximum temperature showed significant and negative correlation in the Cauvery delta zone, and rainfall exhibited significant and positive correlation in the high rainfall zone. Weather plays an important role in

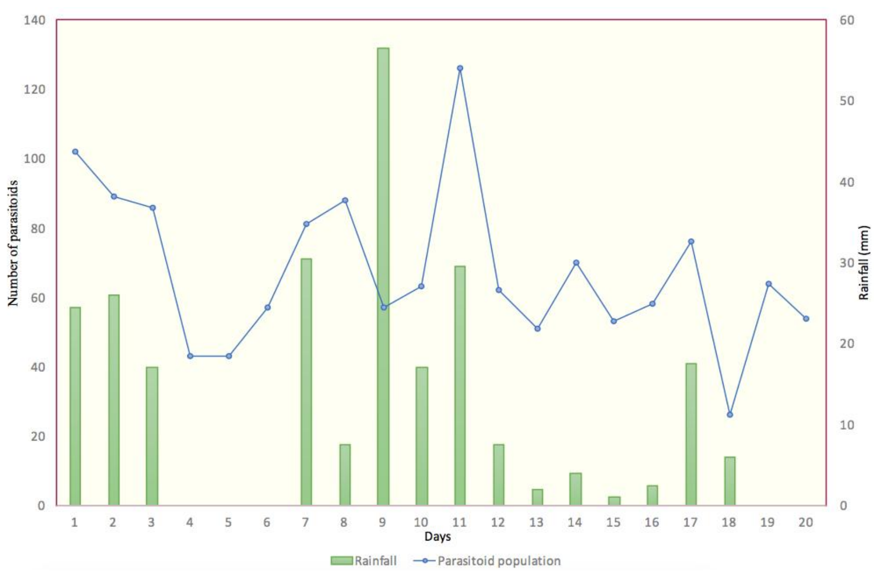

Fig. 1. Parasitoids in rice- positive correlation vs. rainfall (high rainfall zone)

Table 4. Correlation coefficient (r) of parasitoid catches with daily weather parameters

Weather parameters	Western zone	Cauvery delta zone	High rainfall zone
Max. Temperature (°C)	-0.211	-0.485*	0.008
Min. Temperature (°C)	-0.120	0.085	-0.067
Relative Humidity (%)	-0.026	0.066	0.207
Rainfall (mm)	-0.054	0.423	0.483*

Significant at p= 0.05*

Fig. 2. Parasitoids in rice- negative correlation vs. maximum temperature (Cauvery delta zone)

tritrophic interactions among parasitoids, as it influences the level of control that natural enemies exert (Huffaker et al., 1971), and the temperature plays an important role (Mavi and Tupper, 2005).

Lack of success in biological control programs has often been caused by high mortality of natural enemies due to climatic extremes. The present study showed that maximum temperature had a significant negative correlation effect on parasitoid population levels in Cauvery delta zone (Fig. 2). Innundative release of parasitoids for biological control should be planned accordingly. The relationship between temperature and parasitoids populations is usually calculated as linear, but it is actually curvilinear (Sharpe and DeMichele, 1977). Studies conducted by McFarland and Hoy (2001) revealed decreased survival of parasitoid population when the temperature increased from 25 to 30°C. Both hosts and parasitoids are affected by extreme temperatures, and any effect on the host has consequences on the inhabiting parasitoids.

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