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Research Article

The occurrence of rice hispa, *Dicladispa armigera* (Oliver) and its parasitoid, *Chrysonotomyia* sp. under mid-hill conditions of Himachal Pradesh

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ABSTRACT: Systematic observations as carried out in selected experimental plots and farmers field at CSK Himachal Pradesh Krishi Vishvidyalaya, Rice and Wheat Research Centre, Malan (HP) during *kharif* 2015 and 2016, revealed that the rice hispa (adults) started infesting the paddy crop early in the season at 26th Standard Meteorological Week (SMW) and it continued till the crop matures (40-44th SMW). The grub incidence was reported from 28-39th SMW. Simultaneously, random samples of mined leaves were collected from the surveyed plots, brought to the laboratory, examined for field parasitism symptoms, maintained and reared for further investigations, recovered the association of hispa grubs or pupae with a gregarious parasitoid, which was identified as *Chrysonotomyia* sp. (Hymenoptera: Eulophidae: Entedoninae). Also, the maximum parasitization rates for this vary species of parasitoid were recorded during 34-39th SMW, with the mean parasitization of 46.0 and 39.3 percent during *kharif* 2015 and 2016, respectively. The natural parasitization of grubs or pupae of rice hispa by *Chrysonotomyia* sp. was reported for the first time from the state and it thus could be exploited as an important biological tool under the sustainable approach for its integrated management.

KEY WORDS: Grubs, parasitization, pupae, rice hispa, SMW

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INTRODUCTION

Rice hispa, *Dicladispa armigera* (Oliver) (Coleoptera: Chrysomelidae) earlier known to be a sporadic insect-pest of paddy, has assumed the status of major pest in many rice growing regions of the country (Polaszek *et al.,* 2002; Islam *et al.,* 2004; Hazarika *et al.,* 2005; Bhattacharjee and Ray, 2010; Chakraborty and Deb, 2012). Outbreaks of this pest have also been reported from the Kangra valley of Himachal Pradesh for the last few years that has added to its regional significance in limiting the production and productivity of rice (Choudhary *et al.,* 2001 and Sharma *et al.*, 2012). Thorough investigations on insect's seasonal occurrence and its associated natural enemies explore the ways in determining and developing the suitable as well as sustainable management strategy and hence, the present investigations were made for rice hispa infesting paddy.

MATERIAL AND METHODS

Since rice hispa is a pest of sporadic occurrence, hence, the study of its population estimation was undertaken at nearby farmer's fields (Pharer Haar and Jia), where in this pest had been continuously reported to occur very frequently from last couple of years, besides the regular studies at experimental farm of CSK Himachal Pradesh Krishi Vishvidyalaya, Rice and Wheat Research Centre, Malan (Himachal Pradesh). Starting from nursery to mature grain stage, the paddy crop (cv. Kasturi Basmati) was surveyed regularly. Observations on its seasonal occurrence were made at weekly intervals (Standard Meteorological Week, SMW) and both the adult (5 random diagonal sweeps along the four corners of the field were made using sweep net) and grub incidence (per 10 random rice hills) were assessed by calculating the mean.

For the association of natural enemies, during the period of study, the crop was regularly surveyed and observations on associated natural enemies were recorded. For parasitization rates, random samples of mined leaves (30 in number) with grubs (or pupae) were collected from surveyed plots as soon as the grubs started infesting paddy, brought to the laboratory, examined for field parasitism symptoms and further reared under laboratory conditions. Parasitoid that emerged from the mines in the laboratory was identified. Field collected or laboratory-maintained mines showing parasitization symptoms (mummified car-

cass with visible parasitoid cocoons and/or parasitoid emergence holes) were considered to calculate the rate of parasitization which is as under:

$$\text{Parasitization (\%)} = \frac{\text{Number of parasitized grubs or pupae}}{\text{Total number of mined grubs or pupae sampled}} \times 100$$

RESULTS AND DISCUSSION

The adults started appearing with the early monsoon showers during the month of June (on weeds *viz*. *Cyanodon dactylon* (Linn.), *Cyperus rotundus* (Linn.), *Andropogon gayanus* (Kunth), *Digitaria sanguinalis* (Linn.) and *Panicum dichotomiflorum* Michx., etc) and shifted to paddy crop as soon as it was transplanted (July, 26th SMW), thereafter, it started building-up. The maximum proportions of adults were caught during the months of August-September (31-39th SMW), which were 35 and 43.3 per cent for the year 2015 and 2016, respectively. Adults remained associated with the crop till its maturity (October-November), however, the grub incidence was reported only in the early stages from 28th SMW upto 39th SMW and the maximum proportion of grubs were extracted during August (78.1 and 66.4%, for 2015 and 2016, respectively) (Tables 1-2). Earlier studies by Choudhary et al. (2001) from Himachal Pradesh reported maximum population of adults and grubs in the month of August which justified current findings. Bhattacharjee and Ray (2010) reported peaks of rice hispa population in Assam during the month of September and October. Similar population dynamics of rice hispa was reported by Chakraborty and Deb (2012) from West Bengal, who observed the maximum abundance of adults during 36-38th SMW.

Table 1. Occurrence of *Dicladispa armigera* on paddy during 2015

Month	SMW	Adults (no./5 sweeps)		Mean*	Proportion of adults/ month (%)	Grubs (no./10 hills)		Mean*	Proportion of grubs/ month (%)
		L1	L2			L1	L2		
JUNE	25	2.3	0.0	1.2	0.6	0.0	0.0	0.0	0.0
	26	1.7	0.0	0.8		0.0	0.0	0.0	
JULY	27	1.0	0.0	0.5	4.0	0.0	0.0	0.0	9.3
	28	0.0	0.0	0.0		6.3	0.0	3.2	
	29	11.0	0.7	5.8		7.3	1.0	4.2	
	30	9.3	3.7	6.5		9.0	3.0	6.0	
AUG	31	18.3	4.7	11.5	33.0	8.7	5.0	6.8	78.1
	32	18.0	14.7	16.3		26.0	22.0	24.0	
	33	28.0	17.3	22.7		33.3	35.3	34.3	
	34	36.3	21.3	28.8		10.7	44.7	27.7	
	35	26.0	26.3	26.2		17.0	21.7	19.3	
SEPT	36	41.0	29.3	35.2	35.0	8.3	12.3	10.3	12.6
	37	36.7	23.3	30.0		4.3	6.7	5.5	
	38	26.7	23.7	25.2		1.7	1.3	1.5	
	39	21.3	22.0	21.7		0.7	1.0	0.8	
OCT	40	24.7	17.3	21.0	23.8	0.0	0.0	0.0	0.0
	41	29.0	18.0	23.5		0.0	0.0	0.0	
	42	17.7	15.0	16.3		0.0	0.0	0.0	
	43	7.7	8.0	7.8		0.0	0.0	0.0	
	44	5.3	9.7	7.5		0.0	0.0	0.0	
NOV	45	0.0	6.0	3.0	3.6	0.0	0.0	0.0	0.0
	46	3.3	8.7	6.0		0.0	0.0	0.0	
	47	0.0	3.0	1.5		0.0	0.0	0.0	
	48	0.0	2.0	1.0		0.0	0.0	0.0	
Total =				320.0				143.7	

Note: SMW = Standard Meteorological Week, *mean of two locations (Pharer Haar and Malan)
Location L1 = Pharer Haar (transplanted during June (26thSMW), harvested during Oct (42nd SMW))
Location L2 = Malan (transplanted during July (29nd SMW), harvested during Nov (45th SMW))
Prior to transplanting and after harvest the abundance was recorded on paddy nursery/weed hosts/bunds

Table 2. Occurrence of *Dicladispa armigera* on paddy during 2016

Month	SMW	Adults (no./5 sweeps)			Mean*	Proportion of adults/month (%)	Grubs (no./10 hills)			Mean*	Proportion of grubs/ month (%)
		L1	L2	L3			L1	L2	L3		
JUNE	22	0.0	1.0	0.0	0.3	1.5	0.0	0.0	0.0	0.0	0.0
	23	0.0	1.0	0.0	0.3		0.0	0.0	0.0	0.0	
	24	0.0	2.3	0.0	0.8		0.0	0.0	0.0	0.0	
	25	0.0	1.0	0.0	0.3		0.0	0.0	0.0	0.0	
	26	0.0	3.0	0.0	1.0		0.0	0.0	0.0	0.0	
JULY	27	1.0	4.0	0.0	1.7	14.7	0.0	0.0	0.0	0.0	18.7
	28	10.0	7.3	0.0	5.8		7.0	7.3	0.0	4.8	
	29	6.0	14.3	0.0	6.8		8.3	12.7	0.0	7.0	
	30	14.0	21.3	2.3	12.6		30.3	21.3	0.0	17.2	
AUG	31	18.3	16.7	16.0	17.0	43.3	23.7	22.0	6.0	17.2	66.4
	32	3.0	23.7	21.0	15.9		2.7	24.0	36.7	21.1	
	33	2.0	30.7	3.0	11.9		6.7	32.7	16.0	18.4	
	34	2.3	30.0	10.3	14.2		2.3	33.3	26.3	20.7	
	35	0.0	54.7	5.0	19.9		0.0	49.3	27.7	25.7	
SEPT	36	0.0	58.0	2.3	20.1	36.9	0.0	36.7	13.7	16.8	14.9
	37	0.0	59.3	0.0	19.8		0.0	12.3	2.0	4.8	
	38	0.0	54.0	0.0	18.0		0.0	4.7	0.0	1.6	
	39	0.0	28.0	0.0	9.3		0.0	0.0	0.0	0.0	
OCT	40	0.0	12.0	0.0	4.0	3.0	0.0	0.0	0.0	0.0	0.0
	41	0.3	1.3	0.0	0.6		0.0	0.0	0.0	0.0	
	42	0.0	1.0	0.0	0.3		0.0	0.0	0.0	0.0	
	43	0.0	1.7	0.0	0.6		0.0	0.0	0.0	0.0	
	44	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0	
NOV	45	0.0	3.3	0.0	1.1	0.6	0.0	0.0	0.0	0.0	0.0
Total =					182.2					155.2	

Note: SMW = Standard Meteorological Week, *mean of three locations (Pharer Haar, Jia and Malan)
Location L1 = Pharer Haar (transplanted during July (27thSMW), harvested during Oct (44th SMW))
Location L2 = Jia (transplanted during June (26th SMW), harvested during Oct (44th SMW))
Location L3 = Malan (transplanted during July (29ndSMW), harvested during Nov (45th SMW))
Prior to transplanting and after harvest the abundance of adults was recorded on paddy nursery/weed hosts/bunds

As far as the association of natural enemies, a gregarious parasitoid, *Chrysonotomyia* sp. (Hymenoptera: Eulophidae: Entedoninae) (Plate 1) was found associated with *D. armigera* grubs (or pupae). The genus of parasitoid (*Chrysonotomyia*) was identified based on keys described by Hansson (1990) and Gumovsky (2001). Data on parasitization for the years 2015-2016 are being presented in Tables 3-5.

Based on 30-mined grubs (or pupae) sampled during the regular weekly surveys (*kharif* 2015), it could be revealed that at the early stages of parasitization, no parasitization symptoms were recovered or observed on samples collected from the field (Table 3). The first mummified grubs with visible cocoons of parasitoid were observed at 32nd SMW. Several grubs (or pupae) in mines located in field surveys showed parasitoid emergence holes during late August and September months, which indicated parasitoid activity in the field. In the next season (2016), the field symptoms of parasitization appeared early (30th SMW) at Pharer Haar and Jia. At Malan, mummified grubs with parasitoid cocoons were recovered for the first time during 33rd SMW. However, the samples with parasitoid emergence holes were observed during the month of August and September (Table 4).

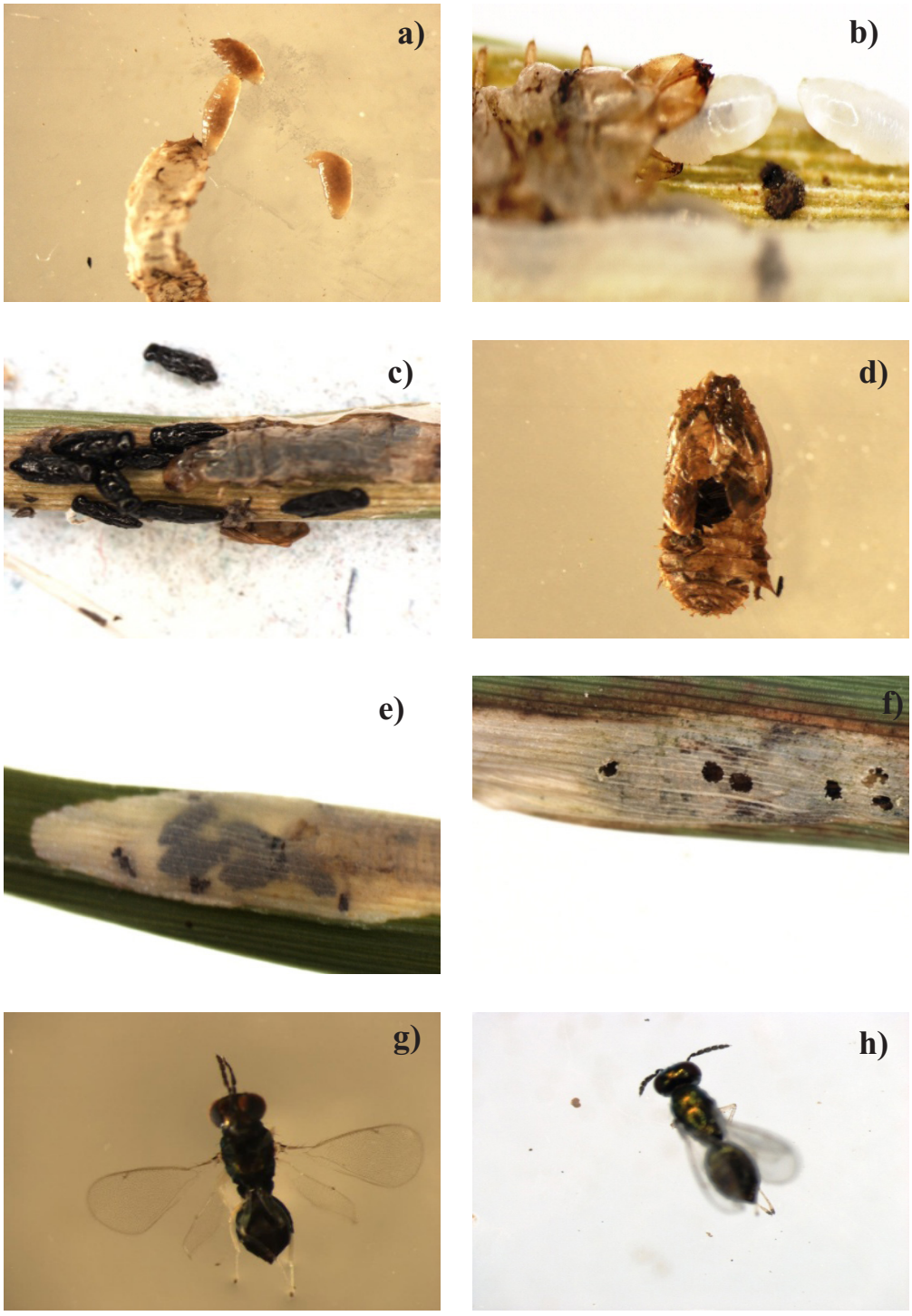

Plate 1. Parasitization of rice hispa by *Chrysonotomyia* sp. a) Immatures (nymphs) of parasitoid, b) early stage parasitoid cocoons emerging from mouth opening of parasitized grub, c) parasitized grub with cocoons of parasitoid, d) parasitized pupa, e) parasitoid cocoons within the mined leaf, f) dispersed parasitoid emergence holes on mined leaf, g) and h) adults of parasitoid.

Table 3. Per cent parasitization of rice hispa grubs or pupae by its eulophid parasitoid, *Chrysonotomyia* sp. during *kharif* 2015

Month	SMW	Count based on 30 mined leaf samples with grubs or pupae*				Per cent parasitization [((II+III+IV)/30)*100]
		Healthy grubs/pupae (I)	Parasitized grubs/pupae (II)	Empty parasitized mines (III)	Parasitized grubs/pupae** (IV)	
Location: PharerHaar						
July	28	30	0	0	0	0.0
	29	30	0	0	0	0.0
	30	30	0	0	1	3.3
Aug	31	30	0	0	2	6.7
	32	27	3	0	4	23.3
	33	24	6	0	3	30.0
	34	19	21	0	0	70.0
	35	11	18	1	5	80.0
Sept	36	7	20	3	0	76.7
	37	14	0	16	1	56.7
	38	7	6	17	0	76.7
	39	8	7	15	0	73.3
Mean =						**41.4**
Location: Malan						
July	29	30	0	0	0	0.0
	30	30	0	0	0	0.0
Aug	31	30	0	0	0	0.0
	32	26	4	0	1	16.7
	33	21	9	0	2	36.7
	34	9	21	0	0	70.0
Sept	35	7	21	2	0	76.7
	36	5	13	12	0	83.3
	37	4	12	14	0	86.7
	38	7	16	7	2	83.3
	39	6	9	15	0	80.0
Mean =						**48.5**

Note: *at the time of collection from surveyed plots
(I)- were further reared under laboratory
(II)- marked as mummified grub or pupae and visible cocoons of parasitoids
** (IV)-those obtained from the healthy grubs or pupae collected from field (I)

Table 4. Per cent parasitization of rice hispa grubs or pupae by its eulophid parasitoid, *Chrysonotomyia* sp. during *kharif* 2016

Month	SMW	Count based on 30 mined leaf samples with grubs/pupae*				Per cent parasitization [((II+III+IV)/30)*100]
		Healthy grubs/pupae (I)	Parasitized grubs/pupae (II)	Empty parasitized mines (III)	Parasitized grubs/pupae** (IV)	
Location: PharerHaar						
July	28	30	0	0	0	0.0
	29	30	0	0	0	0.0
	30	25	5	0	3	26.7
Aug	31	28	2	0	9	36.7
	32	23	4	3	10	56.7
	33	29	1	0	12	43.3
	34	14	11	5	6	73.3
Mean =						33.8
Location: Malan						
Aug	31	30	0	0	0	0.0
	32	30	0	0	3	10.0
	33	29	1	0	7	26.7
	34	18	12	0	4	53.3
Sept	35	19	8	3	6	56.7
	36	12	7	11	0	60.0
	37	3	9	18	0	90.0
Mean =						42.4
Location: Jia						
July	28	30	0	0	0	0.0
	29	30	0	0	0	0.0
	30	27	3	0	1	13.3
Aug	31	27	1	2	2	16.7
	32	30	0	0	4	13.3
	33	30	0	0	3	10.0
	34	22	4	4	0	26.7
Sept	35	18	7	5	5	56.7
	36	9	18	3	0	70.0
	37	9	7	14	1	73.3
	38	4	5	21	0	86.7
Mean =						33.3

Note: *at the time of collection from surveyed plots
(I)- were further reared under laboratory
(II)- marked as mummified grub or pupae and visible cocoons of parasitoids
**(IV)-those obtained from the healthy grubs or pupae collected from field (I)

Table 5. Prevalence of *Chrysonotomyia* sp. on *Dicladispa armigera* infesting paddy

Month	SMW	Per cent parasitization*	
		2015	2016
July	28	0.0	0.0
	29	0.0	0.0
	30	1.7	20.0
Aug	31	11.7	17.8
	32	30.0	26.7
	33	50.0	26.7
	34	73.3	51.1
	35	81.7	56.7
Sept	36	81.7	65.0
	37	70.0	81.7
	38	78.3	86.7
	39	73.3	-
Mean =		46.0	39.3

*Mean values derived from Table 3 and 4

The prevalence of *Chrysonotomyia* sp. as assessed by the mean parasitization rates of different locations during the two years (Table 5) revealed that the parasitization initiated as early as during 30th SMW and remained associated until the grub incidence was recorded in the paddy fields (39th SMW). The mean per cent parasitization during this period varied from 1.7-81.7 (*kharif* 2015) and 17.8-86.7 (*kharif* 2016). The overall mean parasitization during the year 2015 and 2016 were 46.0 and 39.3 per cent, respectively. Also, from a single parasitized mine as many as 3-14 parasitoid cocoons were recovered, indicating its gregarious nature. Several workers have reported the association of many hymenopteran parasitoids with hispa eggs and grubs. About 22.8 per cent parasitization of grubs by eulophid and braconid wasps was reported by Islam and Rabbi (1998). Bhattacharyya *et al.* (2010) also reared *Bracon hispae* and *Chrysonotomyia* sp. from the grubs of *D. armigera*, however, the braconid wasps were not observed to be associated with rice hispa in current studies. Similar parasitization symptoms of mummified carcass and emergence holes were recovered from grubs and pupae of leaf miner, *Asamangulia cuspidata* Maulik when parasitized by *Bracon* sp. (Hymenoptera: Braconidae), *Pediobius* spp. (Hymenoptera: Eulophidae) and *Eurytoma* sp. (Hymenoptera: Eurytomidae) as reported in the studies by Srikanth *et al.* (2015). The association of this eulophid wasp with rice hispa grubs (or pupae) in Himachal Pradesh, being the first report from the state (Srivastava *et al.,* 2015), could be exploited as an important biological measure in the integrated management of rice hispa. However, further and thorough investigations are needed to explore different aspects of its association with rice hispa along with its hyperparasitoids, other natural enemies, and their compatibility with different management options.

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