Seasonal Incidence and Parasitization of Diaeretiella rapae (McIntosh) on Mustard Aphid, Lipaphis erysimi in Indian mustard (Brassica juncea): A Report from Jobner, Rajasthan

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Abstract

Mustard aphid, *Lipaphis erysimi* (Kaltenbach), is a major pest of Indian mustard (*Brassica juncea*) that inflicts significant yield losses under Rajasthan's semi-arid conditions. Its population dynamics and natural regulation by parasitoids are influenced by prevailing weather factors. The present report was undertaken at Sri Karan Narendra Agriculture University, College of Agriculture, Jobner, Rajasthan, during two consecutive *Rabi* seasons (2022–23 and 2023–24) to study the seasonal incidence of *Lipaphis erysimi* and its parasitisation by *Diaeretiella rapae* (McIntosh) in relation to meteorological parameters. Mustard variety Giriraj was raised under field conditions and weekly observations on aphid density and percent parasitization were recorded. Aphid infestation appeared in late December and early January, reaching peak densities in late January to early February and subsequently declined by March. Parasitization by *D. rapae* was first recorded in the third week of February during both years, with a peak of 29.62% in the second week of March 2023 and 34.54% in the same period of 2024. Correlation studies revealed a significant positive association of parasitization with maximum and minimum temperatures in 2022–23, while relative humidity showed a significant negative relationship in 2023–24. Rainfall exhibited a non-significant negative association across both years. This report emphasizes the seasonal role of *D. rapae* as an effective natural enemy of mustard aphid, underscoring its potential utility in integrated pest management programs for mustard cultivation in Rajasthan.

INTRODUCTION

Mustard aphid, *Lipaphis erysimi* (Kaltenbach), is one of the most destructive insect pests of Indian mustard *Brassica juncea* (L.) Czern and Coss, causing severe yield losses under field conditions, with 6–7 percent reduction in oil content (Shylesha et al. 2006). Indian mustard is one of the important oil seed crop grown in Jobner, Rajasthan, where the aphid population is regulated by several natural predators like coccinellids and syrphid fly (Mishra and Kanwat, 2018 and Arvind et al., 2024) and apart from them, *Diaeretiella rapae* (McIntosh) a broconid parasitoid is the most efficient among the natural enemies, which is a polyphagous and cosmopolitan parasitoid reported from 98 aphid species on more than 180 plant hosts belonging to 43 families in 87 countries worldwide (Singh and Singh 2015). It has been recorded parasitizing the green peach aphid, *Myzus persicae* (Sulzer), cabbage aphid, *Brevicoryne brassicae* (Linnaeus) and mustard aphid, *L. erysimi* (Soni et al. 2022), with maximum emergence success from *L. erysimi* population (Halder et al. 2014). The parasitoid has high reproductive potential and a single mated female may parasitize up to 94 aphids within three days (Sehgal et al. 2023), highlighting its utility in biological control programs. Soni and Kumar (2021) reported that *D. rapae* is capable of parasitizing all the nymphal instars of aphid. Floral resources, including weeds and non-weeds, like buckwheat, alyssum, shepherd's purse and white rocket improve *Diaeretiella rapae* performance, with buckwheat most effective enhance parasitoid survival and fecundity in agroecosystems (Araj and Wratten 2015). Therefore, *D. rapae* stands out as a key natural enemy of mustard aphid, with its broad host range, high parasitization potential and successful emergence making it an important component in integrated aphid management strategies.

MATERIALS AND METHODS

Field experiments were conducted during the *Rabi* seasons of 2022–23 and 2023–24 at the Research Farm, Sri Karan Narendra Agriculture University (SKNAU), College of Agriculture (COA), Jobner, Rajasthan, to investigate the seasonal incidence of the mustard aphid *Lipaphis erysimi* (Kaltenbach) and its parasitoid *Diaeretiella rapae* (McIntosh) in relation to meteorological factors. The mustard variety 'Giriraj' was sown in the first fortnight of November in five plots following a Randomized Block Design (RBD) and weekly observations on aphid population and parasitisation were recorded from ten randomly selected and tagged plants in each plot. The number of live aphids and mummified aphids was counted and per cent parasitization was calculated with formula:

Per cent parasitization = (Mummified aphids ÷ Total number of aphids) × 100.

Meteorological data on temperature, relative humidity and rainfall were obtained from the Agrometeorological Observatory, SKNAU, Jobner and Correlation between aphid population, parasitism by *Diaeretiella rapae*, and meteorological parameters (temperature, relative humidity and rainfall) was computed using Pearson's correlation method. Significance of correlation coefficients was tested at both **1% ($P \leq 0.01$)** and **5% ($P \leq 0.05$)** probability levels.

RESULTS AND DISCUSSION

The parasitoid *Diaeretiella rapae* (McIntosh) (Fig. 1–4) was observed parasitizing the mustard aphid, *Lipaphis erysimi*, on Indian mustard at SKNAU, College of Agriculture, Jobner. This observation is significant, as earlier studies from Jobner (Mandarwal 2014; Mishra and Kanwat 2018; Dotasara 2019; Arvind 2021; Chand 2022) and Jaipur (Yadav et al. 2023) documented only predatory natural enemies associated with mustard aphid in Indian mustard. Although *D. rapae* had previously been reported from Jobner by Khinchi and Kumawat (2012) on *Rhopalosiphum maidis* infesting blond psyllium (*Plantago ovata*), the present study records its occurrence parasitizing *L. erysimi* within the mustard ecosystem.

In the present study (Tables 1 and 2), parasitism was first recorded in the third week of February (7th SMW) during *Rabi* 2022–23 and 2023–24, with initial parasitism levels of 5.04% and 3.80%, respectively. Activity peaked in the second week of March (10th SMW), reaching 29.62% in 2022–23 and 34.54% in 2023–24, under moderately high temperatures (28–31°C maximum; 8–11°C minimum) and relatively low relative humidity (36–53%). These observations align with earlier reports that *D. rapae* activity generally begins in late January to early February and peaks thereafter (Kulkarni and Patel 2001, Lal et al. 2018). They are also consistent with Dhiman (2007), who noted that adult populations increased from February to May on mustard, declined in October and were absent during November to late January, with pupal diapause facilitating overwintering and productive mummies yielding adults by late January to early February. Souza et al. (2017) further demonstrated that the biological features of *D. rapae* are influenced by both temperature and host, with higher temperatures improving host quality and enhancing parasitoid development and performance. Similarly, Rupawat 2007 and Soni et al. (2022) observed that percent

parasitism by *D. rapae* gradually increased with rising temperatures in March, coinciding with crop maturity.

Correlation analysis (Table 3) indicated a negative, non-significant relationship between aphid population and parasitism by *D. rapae* (r = − 0.244 in 2022–23; r = − 0.282 in 2023–24), This negative, non-significant correlation between aphid abundance and parasitism likely reflects lagged density-dependent responses, as *D. rapae* activity commenced after the aphid population peak, a pattern observed in other aphid–parasitoid systems (Rochat, 1997; Nematollahi et al., 2014) and consistent with climate driven phenological mismatches reported by Tougeron (2020). Parasitism was positive and significantly correlated with maximum and minimum temperatures in 2022–23 (r = 0.693 and 0.800) (Table 3), consistent with Lal et al. (2018) and Soni et al. (2021). In 2023–24 (Table 3), the correlation with temperature remained positive but was non-significant (r = 0.438 and 0.474), in line with reports by Achintya *et al.* (2012), Kashyap et al. (2018) and Nisha et al. (2018). Relative humidity exerted a negative influence on parasitism, being significantly correlated in 2023–24 (r = − 0.552) (Table 3), supporting earlier findings that high humidity suppresses parasitoid activity (Akhtar et al. 2010; Lal et al. 2018; Kashyap et al. 2018; Soni et al. 2021). Rainfall exhibited a negative, non-significant effect in both years (Table 3), in contrast to the positive, non-significant associations reported by Nisha et al. (2018), Pradhan *et al*. (2020) and Soni et al. (2021), which may be attributed to the low and sporadic rainfall characteristic of the Jobner region.

Table 1

Correlation of mustard aphid (Lipaphis erysimi) with weather parameters and per cent parasitization by Diaeretiella rapae. during Rabi, 2022–23

SMW	Max Temp (°C)	Min Temp (°C)	Average RH (%)	Total Rainfall (mm)	Aphids (10 cm terminal shoot)	Per cent Parasitization by *D. rapae*.
47	27.6	4.9	46	0	0.00	0.00
48	27.9	4.8	49	0	0.00	0.00
49	25.5	3.7	55	0	0.00	0.00
50	26.5	4.6	54	0	0.00	0.00
51	25.5	4.6	58	0	0.00	0.00
52	23.3	2.2	56	0	0.00	0.00
1	20.7	-1.0	60	0	10.34	0.00
2	24.5	4.9	55	0	49.84	0.00
3	20.1	-0.5	55	0	99.08	0.00
4	21.3	3.6	61	0	120.64	0.00
5	22.0	5.2	69	0	172.28	0.00
6	26.9	6.9	56	17	122.64	0.00
7	28.4	5.8	51	0	86.52	5.04
8	31.9	9.8	49	0	29.30	11.08
9	32.1	12.0	49	0	12.64	26.08
10	30.7	11.3	53	3	2.38	29.62

 Note: SMW = Standard Meteorological Week.

Table 2

Correlation of mustard aphid (*Lipaphis erysimi*) with weather parameters and per cent parasitization by *Diaeretiella rapae*. during Rabi, 2023–24

SMW	Max Temp (°C)	Min Temp (°C)	Average RH (%)	Total Rainfall (mm)	Aphids (10 cm terminal shoot)	Per cent Parasitization by *D. rapae*.
47	28.1	8.1	45	0.0	0.00	0.00
48	24.5	10.7	64	1.0	0.00	0.00
49	25.3	8.3	61	0.0	0.00	0.00
50	26.6	5.5	56	0.0	0.00	0.00
51	25.0	5.5	51	0.0	0.00	0.00
52	25.0	4.9	60	0.0	20.16	0.00
1	17.0	3.5	69	0.0	89.74	0.00
2	21.9	3.3	57	0.0	91.54	0.00
3	23.2	3.5	55	0.0	94.32	0.00
4	24.0	4.3	52	0.0	110.16	0.00
5	26.0	11.1	57	2.0	120.38	0.00
6	22.9	6.6	53	2.4	140.42	0.00
7	26.6	7.2	50	0.0	72.96	3.80
8	28.0	10.4	52	0.0	45.38	10.66
9	26.4	11.6	56	0.0	20.76	25.28
10	28.3	8.9	36	0.0	7.58	34.54

 Note: SMW = Standard Meteorological Week.

Table 3
Correlation of per cent parasitization of *Lipaphis erysimi* by *Diaeretiella rapae*. with weather parameters during Rabi, 2022–23 and 2023–24

Parameter	Rabi 2022–23	Rabi 2023–24
***D.rapae* with aphid**	**-0.244**	**-2.82**
Maximum Temp	**0.693****	**-0.438**
Minimum Temp	**0.800****	**-0.474**
Relative Humidity	**-0.350**	**-0.552***
Rainfall	**-0.001**	**-0.209**
* Significant at 5% probability ** Significant at 1% probability level		

CONCLUSION

This study reports the occurrence of *Diaeretiella rapae* parasitizing mustard aphid, *Lipaphis erysimi*, in the mustard ecosystem of SKNAU, COA, Jobner, Rajasthan, with activity commencing in February and peaking in March. Seasonal dynamics were influenced primarily by temperature and relative humidity, underscoring the role of climatic factors in parasitoid activity. The findings highlight the ecological significance of *D. rapae* as a potential biological control agent against mustard aphid under semi-arid Rabi mustard conditions.

Declarations

Competing Interests:

The authors declare that they have no known competing financial or personal interests that could have appeared to influence the work reported in this paper.

Ethical Approval:

This article does not contain any studies with human participants or animals performed by any of the authors.

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Author Contribution

Thalluri Revanth Sri: Conceptualization, investigation, data collection, data analysis and manuscript preparation. Ram Kishor Meena: Supervision, review and validation of the research methodology. Peruri Vandana: Data recording and assistance in field observations.Aradhana Panda: manuscript editing. All authors read and approved the final manuscript.

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Figures

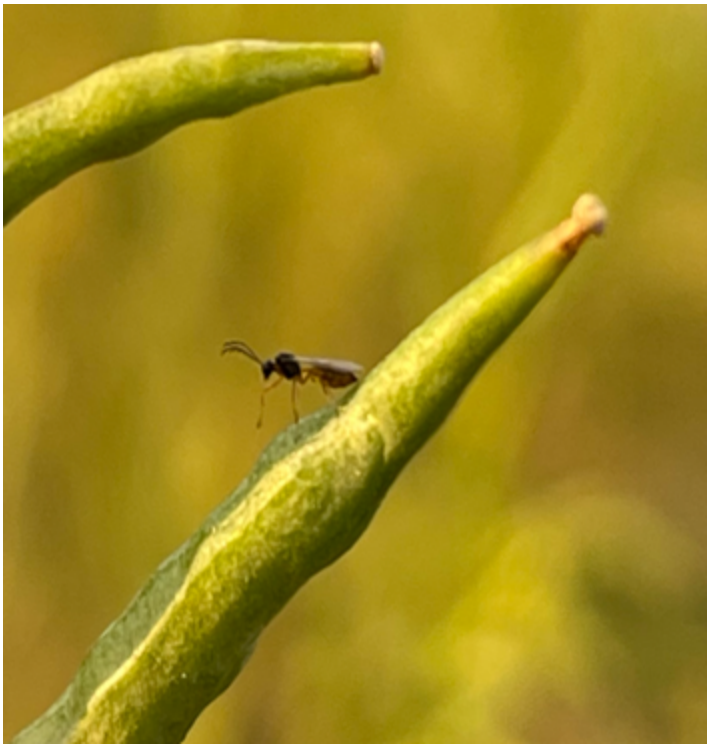

Figure 1

Adult *Diaeretiella rapae*

Figure 2

Parasitized aphid colony

Figure 3

Mummified aphid

Figure 4

Mummified aphids with exit holes