Available online at www.elixirpublishers.com (Elixir International Journal)

Agriculture

Elixir Agriculture 91 (2016) 38183-38186

ISSN: 2229-712X

Impact of Abiotic Factor on Seasonal Occurrence of *Lipaphis Eryisimi and* Its Parasitism by *Diaeretiella Rapae* on different *Brassica* Variety

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ARTICLE INFO

Article history:

Received: 31 December 2015;
Received in revised form:
29 January 2016;
Accepted: 4 February 2016;

Keywords

Mustard Aphid,
Diaeretiella Rapae,
Population Dynamics,
Abiotic Factor
Correlation,
Regression,
Variety.

ABSTRACT

The occurrence of *Diaretiella rapae* parasitizing *Lipaphis erysimi* in *Brassica alba, Brassica campestris* cv. BSH-1, *Brassica carrinata, Brassica nigra, Eruca sativa* cv. T-27, *Brassica juncea* L. cv. Varuna, YST-151 and GSC-6 were evaluated. The correlation coefficients between aphid population and *D. rapae* and its hosts on different Brassica species with different abiotic factors revealed contradictory results. Except for a few instances the weather parameters showed low order of associations with *L. erysimi* and its parasitism by *Diaeretiella rapae*. Thus, the ecological factors exhibited little impact on the population build- up of mustard aphid and its parasitism by *Diaeretiella rapae* on different species of *Brassica*. *Brassica nigra* harboured relatively higher populations of the aphid While, *B. carrinata* and *Eruca sativa* cv. T-27 have lower aphid population.

Introduction

Rapeseed mustard is one of the important oleiferous crops and constitute major source of edible oil for the human consumption and cake for animals. The mustard crop is more vulnerable to a wide variety of insect pests from sowing till harvest than other oil seed crops. The insect pests of economic importance are, cabbage aphid, *Brevicoryne brassica* (L), mustard aphid, *Lipaphis erysimi* (Kalt.),mustard sawfly, *Athalia proxima* (Klug), cabbage butterfly, *Pieris brassicae* (Linn), Painted bug *Bagrada cruciferum*(K.) and Whitefly, *Bemesia tabaci* (Gennedius) (Verma, *et al*. 1993). Aphids are most common and destructive pests of brassicaceous crops across the World, and often cause heavy losses in yield (Shylesha *et al.*, 2006). Parasitoids of aphids are considered to be of importance in natural control of their host populations. The braconid wasp, *Diaeretiella rapae*(M'Intosh), is a solitary endoparasitoid of a wide range of aphids including *Brevicoryne brassicae*(L.) (Fathipour *et al*., 2006), *D. noxia* (Bernal *et al*., 1994,Lester and Holtzer, 2002) and *Lipaphis erysimi* K. (Abidi *et al*., 1987). *D. rapae* is one of the most important factor for natural control of mustard aphid (Dhiman, 2007, Dogra *et al., 2003,* Pike *et al.*, 1999). On the other hand, *D. rapae* females are more attracted by crucifer plants than by other types of plants (Sheehan & Shelton, 1989, Vaughn *et al.*, 1996). Furthermore, parasites and prey prefer the same host plant possibly because aphids and *D. rapae* positively respond to the volatile compounds produced by the plants (Bundemberg, 1990) and honeydew emitted by aphids and used by its natural enemies as kairomones(Brown *et al.*, 1970, Dicke & Sabelis, 1988). Several studies have been conducted on the functional response of *D. rapae* on different aphid species such as *B. brassicae*, *D. noxia*, *M. persicae*, *L. erysimi* and *Schizaphis graminum* (Rondani), but no detailed study has been conducted on the functional response of *D. rapae* at various weather parameters. There is some evidence indicating that temperature can influence the functional response of parasitoids (Mack *et al.*, 1981, Flinn, 1991, Zamani *et al.*, 2006). Therefore, the objective of the current study is to examine the seasonal occurrence of *Lipaphis erysimi* and the relationship between aphids and its parasitoids *Diaeretiella rapae* (M'Intosh) during the crop period and their relationship with different meteorological parameters.

Materials and Methods

Field studies were carried out on the population build-up of *Lipaphis erysimi* (Kaltenbach) and its parasitism by *Diaeretiella rapae* on different species of Brassica during rabi season of 2015 at Crop Research Centre (Pantnagar).The following eight oilseed *Brassica* plants were taken for study: *Brassica alba, Brassica campestris* cv. BSH-1, *Brassica carrinata, Brassica nigra, Eruca sativa* cv. T-27, *Brassica juncea* L. cv. Varuna, YST-151 and GSC-6. Experiments were laid out in Randomized Block Design (RBD) with three replications. Each *Brassica* species was treated as one treatment. Sowing of different oilseed *Brassica* were done on 20th November of during 2014. The plot size of 4m × 3mwas maintained with row to row and plant to plant distances 30 and 10 cm, respectively. During experimentation all the recommended cultural operations were followed to raise the healthy crop except the plant protection measures. Five plants were selected randomly and tagged in each plot. Observations were taken on those tagged plants at alternate day interval.

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Table 1. Population build-up of *L. erysimi* and its parasitism by *Diaeretiella rapae* on different species of *Brassica* under field conditions during 2015

Variety	Aphid population	Mummified aphid	Parasitism (%)
(BSH-1)	107.33	18.42	23.22
(YST-151)	122.96	14.21	25.83
(Varuna)	108.25	17.38	21.28
(GSC-6)	109.83	17.33	23.04
(B. carrinata)	34.50	4.33	16.13
(B. nigra)	147.50	13.58	18.08
(B. alba)	76.38	16.46	45.68
(T-27)	43.71	4.08	10.04

Table 2. Correlation relationship of aphid population on different Brassica variety with weather parameters

Variety	Temperature		Relative humidity		Rainfall	Sunshine	Wind-velocity	evaporation
	Max	Min	Max	Min				
T1 (BSH-1)	-.045ns	.259ns	.729 *	.127ns	.730 *	-.587ns	-.091ns	-.158ns
T2 (YST-151)	.072ns	.305ns	.332ns	-.244ns	.548ns	-.219ns	.296ns	-.051ns
T3 (Varuna)	-.109ns	.092ns	.758 *	.231ns	.609ns	-.549ns	-.208ns	-.112ns
T4 (GSC-6)	-.737 *	-.489ns	.791 *	.886**	.181ns	-.800 *	-.479ns	-.292ns
T5 *(B. carrinata)*	-.162ns	.093ns	.309ns	-.034ns	.246ns	-.475ns	.251ns	-.544ns
T6 (B. nigra)	.029ns	.350ns	.205ns	-.107ns	-.025ns	-.130ns	.597ns	-.512ns
T7 (B. alba)	-.741 *	-.438ns	.658ns	.778 *	.083ns	-.794 *	-.244ns	-.376ns
T8 (T-27)	.359ns	.719 *	.194ns	-.385ns	.364ns	-.093ns	.649ns	-.144ns

*= Significant at 5% level, **= Significant at 1%level

Table 3. Correlation relationship of between *D. rapae* on its hosts on different Brassica variety with weather parameters

Variety	Temperature		Relative humidity		Rainfall	Sunshine	Wind-velocity	evaporation
	Max	Min	Max	Min				
T1 (BSH-1)	-.021ns	.265ns	.148ns	-.052ns	-.157ns	-.077ns	.592ns	-.491ns
T2 (YST-151)	-.047ns	.301ns	.326ns	.048ns	-.018ns	-.194ns	.529ns	-.417ns
T3 (Varuna)	-.452ns	-.165ns	.513ns	.621ns	-.218ns	-.422ns	.067ns	-.395ns
T4 (GSC-6)	-.248ns	.093ns	.281ns	.164ns	-.098ns	-.283ns	.458ns	-.483ns
T5 *(B. carrinata)*	-.052ns	.157ns	.130ns	.008ns	-.212ns	-.120ns	.490ns	-.368ns
T6 (B. nigra)	.052ns	.345ns	.588ns	.031ns	.431ns	-.389ns	.209ns	-.201ns
T7 (B. alba)	.048ns	.382ns	-.043ns	-.130ns	-.166ns	-.049ns	.727 *	-.201ns
T8 (T-27)	.181ns	.435ns	-.261ns	-.287ns	-.295ns	.138ns	.810 *	-.159ns

*= Significant at 5% level, **= Significant at 1%level

Table 4. Quantitative analysis between the population of *L. erysimi* and weather parameters on Brassica species

Variety	Regression equation	R^2
T1 (BSH-1)	$Y= -816.68+22.97X_1-10.69X_2+1.91X_3+6.01X_4+ 11.60X_5-15.28X_6+ 12.87X_7-12.52X_8$	0.991**
T2 (YST-151)	$Y= - 2561.75+53.60X_1-107.43X_2+21.58X_3+4.53X_4+20.58X_5-8.50X_6+ 65.92X_7 +28.48X_8$	0.990**
T3 (Varuna)	$Y= -1913.18+44.35X_1-64.90X_2+12.95X_3+6.18X_4+13.85X_5-13.19X_6+ 36.72X_7 +12.71X_8$	1.00**
T4 (GSC-6)	$Y= 380.11-2.92X_1+21.52X_2-8.58X_3+7.68X_4+3.95X_5-4.22X_6-1.50X_7 - 18.78X_8$	1.009**
T5 *(B. carrinata)*	$Y= - 88.31+1.53X_1-3.47X_2+2.53X_3-1.40X_4-2.85X_5-7.97X_6+2.27X_7 + 1.70X_8$	0.996**
T6 (B. nigra)	$Y= - 1035.91+32.86X_1-51.60X_2+5.51X_3+7.32X_4+11.05X_5-13.33X_6+60.28X_7 - 80.79X_8$	1.002
T7 (B. alba)	$Y= 149.78-6.26X_1+11.95X_2-0.131X_3+0.338X_4-5.02X_5-11.46X_6-0.326X_7 + 3.59X_8$	1.007
T8 (T-27)	$Y= - 319.49\ 5.16X_1+0.373X_2 + 1.93X_3+1.01X_4 +2.09X_5-7.19X_6+10.07X_7 - 11.19X_8$	0.992**

X_1 = max temp, X_2 = min temp, X_3 = max RH, X_4 = min RH, X_5 = rainfall, X_6 = sunshine, X_7= wind -velocity, X_8=evaporation and **=Significant at 1% level

Table 5. Quantitative analysis between the *D. rapae* and weather parameters on Brassica species

Variety	Regression equation	R^2
T1(BSH-1)	$Y=- 167.59+5.31X_1-9.47X_2+0.90X_3+1.12X_4+ 1.81X_5-1.19X_6+ 9.07X_7-8.96X_8$	1.004**
T2(YST-151)	$Y=- 152.19+3.30X_1-5.39X_2+0.926X_3+0.83X_4+ 1.24X_5-0.515X_6+ 5.56X_7-4.15X_8$	0.994**
T3 (Varuna)	$Y=- 74.87+1.29X_1-0.554X_2-0.967X_3+1.30X_4+0.616X_5+0.106X_6+ 3.43X_7-5.40X_8$	1.002**
T4 (GSC-6)	$Y=-88.16+2.70X_1-5.35X_2+ 0.497X_3+0.765X_4+0.996X_5- 1.21X_6+ 6.13X_7-5.15X_8$	1.001**
T5 *(B. carrinata)*	$Y=- 62.91+1.33X_1-2.62X_2+ 0.626X_3+0.473X_4+0.186X_5- 0.824X_6+1.78X_7 + 0.271X_8$	1.001**
T6 *(B. nigra)*	$Y=- 217.04+5.19X_1-7.71X_2+ 1.46X_3+0.723X_4+1.48X_5- 1.79X_6+5.15X_7 + 0.197X_8$	1.003**
T7*(B. alba)*	$Y=17.88+1.06X_1-1.82X_2- 0.322X_3+0.363X_4-0.166X_5- 3.11X_6+5.23X_7 - 2.99X_8$	1.003**
T8 (T-27)	$Y=-15.65-0.244X_1+0.804X_2+ 0.422X_3-0.148X_4-0.605X_5- 1.28X_6+1.27X_7 - 0.565X_8$	0.994**

X_1 = max temp, X_2 = min temp, X_3 = max RH, X_4 = min RH, X_5 = rainfall, X_6 = sunshine, X_7= wind -velocity, X_8=evaporation and **=Significant at 1% level

During the successive period of observations at flowering stage, the number of aphids and mummified (parasitized) aphids were counted on 10 cm apical central shoot of inflorescence. The observations were recorded starting from the first appearance of mummified aphid till the maturity of the crop plants. Based on these counts, incidence of aphid and extent of parasitism due to *D. rapae* was worked out. Activity of the parasitoid were correlated with the population of aphids associated with species of Brassica. Similarly, to determine the association between *D. rapae* and abiotic factors, weekly meteorological data (temperature, relative humidity, sunshine hours, wind speed, evaporation) were correlated with the population of *D. rapae* recorded on all the eight *Brassica* species and correlation coefficient (r) values and regression were worked out.

Result

The aphid population was lowest on the species *B. Carrinata* and T-27 was While, highest number of aphid population found on *B. nigra* followed by YST-151,GSC-6,Varuna, BSH-1 and *B. alba*, respectively.(Rana *et al.,*1995) while studying relative susceptibility of *Brassica* species to mustard aphid *L. erysimi* found that *B. carrinata* had the lowest population of 10.33 aphids/plant which agreement with the present finding. The maximum no. of mummified aphid population was found on BSH-1 followed by Varuna,GSC-6,*B. alba*,YST-151 and *B. nigra*, respectively. While, T-27 and *B. carrinata* have minimum no. of mummified aphid population. The parasitism of *L. erysimi* by *D. rapae* was found on T-27 (10.04%) *B. carrinata* (16.13%) while, highest in *B. alba* (45.68%) followed by YST-151 (25.83%), BSH-1 (23.22%), GSC-6 (23.04 %), Varuna (21.28%) and *B. nigra* (18.08%), respectively(Table 1). The population for *L. erysimi* exhibited significant negative correlation with maximum temperature on GSC-6 and *B. alba*. However, T-27 showed significant positive correlation with minimum temperature. This observation is in conformity with the reports of (Gami *et al*., 2002) observed that aphid population registered significant negative correlation with maximum and minimum temperatures. Maximum relative humidity showed significant positive correlation with the population for *L. erysimi* on BSH-1,Varuna and GSC-6 .While, minimum RH showed significant positive association with GSC-6 and *B. alba* .(Jat *et al.,* 2006) reported the aphid population was significantly and positively correlated with both morning and evening relative humidity. The correlation of population for *L. erysimi* with rainfall was significant positive correlation with BSH-1. *L. erysimi* on GSC-6 had significant positive correlation with sunshine hours. However, wind velocity and evaporation did not have any influence on aphid populations (Table 2).

Significant positive association between *D. rapae* and wind-velocity revealed in *B. alba* and T-27. Wind velocity also influenced positively with the activity of the parasitoid. However, maximum and minimum temperature and relative humidity, sun shine did not have any influence on activity of the parasitoid on the different *Brassica* species. Akhtar *et al.*, 2010 reported that day and night temperature had significant positive correlation with the population of *D. rapae* on mustard. In order to estimate the relation between weather variables with populations of both aphid and parasitoid quantitatively, regression equations were constructed. Where, weather parameter, showed highest influencing factor which contributed for BSH-1(99.1%), YST-151(99%), Varuna (100%), GSC-6(100%), *B. carrinata* (99.6%), *B. nigra* (100%), *B. alba* (100%) and T-27 (99.2%), respectively. The Regression relationship between the population of *L. erysimi* and weather factors was found to be highest influencing factor, which imparted for BSH-1(100%), YST-151(99.4%), Varuna (100%), GSC-6(100%), *B. carrinata* (100%), *B. nigra* (100%) and *B. alba* (99.4%), respectively (Table 3).

Discussion

A braconid parasitoid, *Diaeretiella rapae* (Mclntosh) (Hymenoptera: Braconidae) is a solitary endoparasitoid and cosmopolitan in distribution. The knowledge of the aphid parasitoid- plant associations is one of the main elements when developing integrated management strategies. The present finding showed highest population of aphid on *B. nigra* while *B. carrinata* had the lowest aphid population and maximum no. of mummified aphid population was found on BSH-1 and *B. carrinata* have minimum no. of mummified aphid population. The lowest level of parasitism of *L. erysimi* by *D. rapae* was found on T-27 and highest in *B. alba.*It was noticed that the correlation of the population for *L. erysimi and* Its Parasitism by *Diaeretiella rapae* with weather parameters were non-significant in most of the *Brassica* varieties of year 2015. The values of coefficient of determination (R^2) were high (1.00 to 0.99), it indicated that the population for *L. erysimi* and its parasitism by *Diaeretiella rapae* on different species of *Brassica* governed significantly with the weather parameters in the crop season 2015.

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