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Multiplication index of *Lipaphis erysimi* on mustard cultivars under *in-vitro* conditions

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Abstract
Mustard cultivars were screened under *in-vitro* conditions for their resistance to *Lipaphis erysimi*. Forty five cultivars of mustards were tested against *Lipaphis erysimi* (Kaltenbach). The results were categorized based on aphid multiplication index values. Lowest aphid multiplication index values were observed on two cultivars namely Aravali (3.23) and RP-9 (3.93) that were found under highly resistant category (mean aphid multiplication index values less than (4.04).

Keywords: Mustard cultivars, *Lipaphis erysimi*, multiplication index

Introduction
Mustard [*Brassica juncea* (Linneaus) is an important oilseed crop grown in India during *Rabi* season. It was introduced to North-Estern India from China, from where it was extended to Afganistan via, Punjab (Chaudhari, 2008) [2]. India is placed fourth in terms of oilseed production and holds a premier position in rapeseed-mustard economy of the world with 2nd and 3rd rank in area and production, respectively (Anonymous, 2016) [1]. *Lipaphis erysimi* (Kaltenbach) is economically important and key pest of mustard crop. About 41.14% losses were reported by *Lipaphis erysimi* in mustard crop (Dotasara *et al.*, 2018) [4]. Aphids have many generations in a year and have higher fecundity rate due to parthenogenesis. Both the adult and nymph stages suck the cell sap and cause damage to seeds, leaves, inflorescence and stem. In case of severe aphid infestation the production of honey dew is also observed to lead to the growth of fungus on affected plant parts that reduces photosynthesis rate and indirectly affects plant growth and yield (Patel *et al*., 2019) [6]. Present investigations were carried out to record the *in-vitro* multiplication of mustard aphid on various cultivars.

Material and Methods
The polyhouse experiment was conducted at the Department of Entomology, College of Agriculture, JNKVV, Jabalpur, Madhya Pradesh, during *rabi* season of the year 2019-20.
Total 45 mustard cultivars were evaluated for determining multiplication index of aphids under *in-vitro* condition. Sowing was done in third week of November during *rabi* season, 2019-20. The mustard cultivars were grown in poly bags and kept outside the polyhouse till germination. After germination the same was arranged on polyhouse at a distance of 15 x 30 cm to ensure pest free condition. The experiment consisted of 3 replications and was arranged in completely randomized design (CRD). Identical set (set 2) of the experiment was maintained at another polyhouse.
Aphids were collected from the field from infested plants, with the help of soft camel hair brash on a petri plate. Ten aphids (nymphs) were released on each plant (30 days old). Multiplication of aphids was recorded 10 days after release. The multiplication index was calculated using the following formula, as proposed by Sharma (2007) [7].

$$M.\ I. = N1/N2$$

Where
M. I. : Multiplication index
N1 : Aphid number at 10 days after releasing the nymphs
N2 : Number of nymphs (aphids) released initially

Statistical analysis

Construction and categorization of aphid index

The aphid index categorization was worked out on the pointes of inflexion of the normal distribution, as μ, μ+ σ, μ+ 2σ, μ+ 3σ, μ- σ, μ- 2σ, μ- 3σ respectively. The five categories had been shown as given below:

μ - 3σ < HR< μ- 2σ
μ - 2σ < R< μ- σ
μ - σ < MR< μ
μ < MS< μ+ σ
μ + σ < S < μ+ 2σ
μ + 2σ < HS < μ+ 3σ

Where

μ = Mean aphid index value
σ = Standard deviation of mean aphid index value
HR = Highly resistant
R = Resistant
MR = Moderately resistant
MS = Moderately susceptible
S = Susceptible
HS = Highly susceptible

On the other hand, if the categories belong to upper side of the normal distribution and one point below of the distribution than it indicated that our aphid index should be in positively skewed direction. The mean aphid index values were subjected to analysis of variance at 5% level of significance to compare different cultivars.

Result and Discussion

Based on pooled data of both sets, the categorization of various cultivars was done based on preferences and mean aphid multiplication index values. Lowest aphid multiplication index value was recorded on two cultivars namely Aravali (3.23) and RP-9 (3.93) that were found under highly resistant category (mean aphid multiplication index values less than 4.04). Three cultivars namely RVM-2 (4.66), RH-406 (5.04) and Durgamani (5.13) were found under resistant category, showing mean aphid multiplication index values of more than 4.04 but less than 5.13. Thirty-seven cultivars namely JTC-1 (5.21), Maya (5.26), RVM-3 (5.59), GSL-1 (5.6), Gujarat mustard-2 (5.61), IJ-31 (5.63), Shradda (5.63), China Kovind (5.64), RGN-73 (5.64), GSC-7 (5.69), NRC-HB-506 (5.76), RVM-1 (5.76), Kranti (5.88), Bhagirathi (5.90), DRMRIJ-31 (6.0), Jawahar mustard-2 (6.03), Geeta (6.06), SEJ-2 (6.09), Kiran (6.16), NRCDR-2 (6.28), BR-40 (6.29), Basanti (6.33), Ashirwad (6.34), PC-5 (6.36), NRCHB-101 (6.43), Jaganath (6.53), Jawahar mustard-1 (6.56), RH-749 (6.7), Varuna (6.71), Swarn Jyoti (6.79), Gujarat mustard-1 (6.84), JM-3 (7.04), Krishna (7.53), JM-2 (7.63), Pusa Bold (7.71), BSH-1 (7.83) and Lakshmi (7.75), were found moderately resistant, showing mean aphid multiplication index values of more than 513 but less than 8.26.

On the other hand, three cultivars namely YSH-401 (8.3), Rohini (8.48) and NC-1 (8.53), were found moderately susceptible, showing mean aphid multiplication index values of more than 8.26 but less than 9.35.

Table 1: Mean* Scale values of aphid multiplication on 30 days old mustard cultivars (pooled) during *Rabi* 2019-20

Sr. No.	Cultivars	Multiplication index value		Pooled
		Set - 1	Set - 2	
1	Aravali	3.36* (1.96)**	3.1 (1.89)	3.23 (1.93)
2	Ashirwad	6.33 (2.61)	6.36 (2.61)	6.34 (2.61)
3	Basanti	6.16 (2.58)	6.5 (2.64)	6.33 (2.61)
4	Bhagirathi	5.50 (2.44)	6.3 (2.60)	5.9 (2.52)
5	BR-40	6.06 (2.56)	6.53 (2.65)	6.29 (2.60)
6	BSH-1	8.00 (2.91)	7.66 (2.85)	7.83 (2.88)
7	China Kovind	4.96 (2.33)	6.33 (2.61)	5.64 (2.47)
8	DRMRIJ-31	5.70 (2.48)	6.3 (2.60)	6.0 (2.54)
9	Durgamani	5.30 (2.40)	4.96 (2.33)	5.13 (2.37)
10	Geeta	5.73 (2.49)	6.4 (2.62)	6.06 (2.56)
11	GSC-7	5.13 (2.37)	6.26 (2.60)	5.69 (2.48)
12	GSL-1	5.50 (2.44)	5.7 (2.48)	5.6 (2.46)
13	Gujarat mustard-1	6.63 (2.67)	7.06 (2.74)	6.84 (2.70)
14	Gujarat mustard-2	5.70 (2.48)	5.53 (2.45)	5.61 (2.47)
15	IJ-31	5.53 (2.45)	5.73 (2.49)	5.63 (2.47)
16	Jaganath	6.43 (2.63)	6.63 (2.67)	6.53 (2.65)
17	Jawahar mustard-1	6.56 (2.65)	6.56 (2.65)	6.56 (2.65)
18	Jawahar mustard-2	6.13 (2.57)	5.93 (2.53)	6.03 (2.55)
19	JM-2	7.00 (2.73)	8.26 (2.95)	7.63 (2.85)
20	JM-3	7.83 (2.88)	6.26 (2.60)	7.04 (2.74)
21	JTC-1	5.33 (2.41)	5.1 (2.36)	5.21 (2.38)
22	Kranti	5.40 (2.42)	6.36 (2.61)	5.88 (2.52)
23	Kiran	6.10 (2.56)	6.23 (2.59)	6.165 (2.58)
24	Krishna	7.20 (2.77)	7.86 (2.89)	7.53 (2.83)
25	Lakshmi	7.40 (2.81)	8.1 (2.93)	7.75 (2.87)
26	Maya	5.23 (2.39)	5.3 (2.40)	5.265 (2.40)
27	NC-1	8.66 (3.02)	8.4 (2.98)	8.53 (3.00)
28	NRCDR-2	6.16 (2.58)	6.4 (2.62)	6.28 (2.60)
29	NRCHB-101	6.73 (2.68)	6.13 (2.57)	6.43 (2.63)
30	NRC-HB-506	5.36 (2.42)	6.16 (2.50)	5.76 (2.50)
31	PC-5	5.93 (2.53)	6.8 (2.70)	6.36 (2.61)
32	Pusa Bold	8.03 (2.92)	7.4 (2.81)	7.71 (2.86)
33	RGN-73	5.26 (2.40)	6.03 (2.55)	5.64 (2.47)

34	RH-406	5.46 (2.44)	4.63 (2.26)	5.04 (2.35)
35	RH-749	6.70 (2.68)	6.7 (2.68)	6.7 (2.68)
36	Rohini	8.93 (3.07)	8.03 (2.92)	8.48 (2.99)
37	RP-9	3.63 (2.03)	4.23 (2.17)	3.93 (2.10)
38	RVM-1	5.96 (2.54)	5.56 (2.46)	5.76 (2.50)
39	RVM-2	4.43 (2.22)	4.9 (2.32)	4.66 (2.27)
40	RVM-3	5.43 (2.43)	5.76 (2.50)	5.59 (2.46)
41	SEJ-2	5.83 (2.51)	6.36 (2.61)	6.09 (2.56)
42	Shradda	5.83 (2.51)	5.43 (2.43)	5.63 (2.47)
43	Swarn Jyoti	7.23 (2.78)	6.36 (2.61)	6.79 (2.70)
44	Varuna	6.46 (2.63)	6.96 (2.73)	6.71 (2.68)
45	YSH-406	8.20 (2.94)	8.4 (2.98)	8.3 (2.96)
	SE(m)±	0.152	0.136	0.144
	C.D. at 5%	0.427	0.383	0.405

*Mean of five samples and three replications

**Figures in parentheses are transformed ($\sqrt{x+0.5}$) values

Table 2: Categorization of mustard cultivars for their susceptibility to *L. erysimi* based on aphid multiplication index values (pooled)

S. No.	Category of resistance	MAMIV* scale and SD** (Based on normal distribution values)	Cultivars
1	Highly resistant	<4.04	Aravali, RP-9,
2	Resistant	>4.04 but <5.13	RVM-2, RH-406, Durgamani,
3	Moderately resistant	>5.13 but <8.26	JTC-1, Maya, RVM-3, GSL-1, Gujarat mustard-2, IJ-31, Shradda, China Kovind, RGN-73, GSC-7, NRC-HB-506, RVM-1, Kranti, Bhagirathi, DRMRIJ-31, Jawahar mustard-2, Geeta, SEJ-2, Kiran, NRCDR-2, BR-40, Basanti, Ashirwad, PC-5, NRCHB-101, Jaganath, Jawahar mustard-1, RH-749, Varuna, Swarn Jyoti, Gujarat mustard-1, JM-3, Krishna, JM-2, Pusa Bold, BSH-1, Lakshmi,
4	Moderately susceptible	>8.26 but <9.35	YSH-401, Rohini, NC-1,
5	Susceptible	>9.35 but <10.44	
6	Highly susceptible	>10.44	

*Mean aphid multiplication index value $\bar{X}$= 6.22

**Standard deviation = 1.09

Jadon (2008) [5] recorded lowest multiplication index (8.13) on variety Geeta, while the highest multiplication index (12.77) was recorded on variety RK-05-1. Dhillon *et al.* (2018) [3] reported that under artificial infestation screening techniques, genotypes PM 30, PM-21, Pusa bold and Pusa Vijay dispayed variable resistance against *Lipaphis erysimi*.

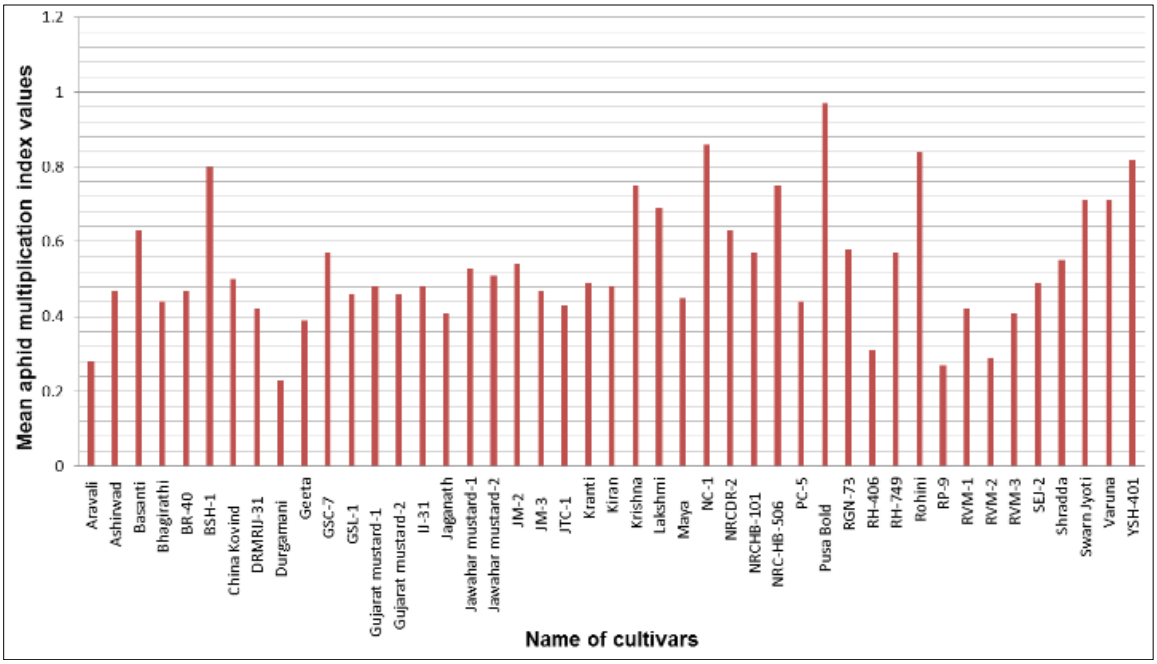

Fig 1: Multiplication index of aphids on different mustard cultivars (pooled)

Conclusion

The results obtained from the *in-vitro* condition which is categorized in highly resistant, resistant, moderately resistant, moderately susceptible, susceptible and highly susceptible respectively. Lower aphid multiplication recorded from Aravali (3.23) and RP-9 (3.93) cultivars, which is categorized under highly resistant. Highly aphid multiplication index values recoded from YSH-401 (8.3), Rohini (8.48) and NC-1 (8.53) cultivars, which is categorized under moderately susceptible.

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