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DIFFERENTIAL RESPONSE OF *BRASSICA* SPECIES TO THE MUSTARD APHID (*LIPAPHIS ERYSIMI* KALTENBACH) IN EASTERN RAJASTHAN

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ABSTRACT

The study on avoidable yield losses in rapeseed–mustard due to mustard aphid (*Lipaphis erysimi* Kaltenbach) was conducted at National Research Centre on Rapeseed–Mustard, Sewar, Bharatpur, consecutively for ten years from 1996–97 to 2005–06 during *Rabi* season under field conditions. The yield losses varied on the infestation intensity of mustard aphid and *Brassica* species. In all the years of experiments, significant higher yields were obtained from protected plots as compared to unprotected plots except during 1998–99 due to negligible infestation of mustard aphid. Over the years, the maximum yield loss of 92.09 per cent was recorded in gobhi sarson (*Brassica napus* var. HYOLA–401) during 2000–01 followed by Indian mustard (*Brassica juncea* var. PCR–7) 90.97 per cent during 1997–98 and brown sarson (*Brassica campestris* var. BSH–1) 90.11 per cent during 1996–97. The minimum yield loss of 5.39 per cent was recorded in taramira (*Eruca sativa* var. T–27) in 2001–02 followed by 5.83 per cent in karan rai (*Brassica carinata* var. BCNRC–1) in 1999–00 and 9.25 per cent in Indian mustard (*B. juncea* var. Varuna) in 2005–06. The mean avoidable yield loss in 10 years of the study, the highest 37.90 per cent was recorded in brown sarson and the lowest 5.61 per cent in taramira. The reduction in oil content was found 0.66 to 8.19 per cent in Indian mustard, 0.22 to 6.81 per cent in brown sarson, 0.08 to 3.01 per cent in yellow sarson, 0.33 to 4.77 per cent in gobhi sarson, 0.02 to 2.67 per cent in karan rai and 0.03 to 2.84 per cent in taramira. The mean oil loss in 10 years was found 1.98 per cent in Indian mustard, 3.12 per cent in brown sarson, 1.83 per cent in yellow sarson, 2.53 per cent in gobhi sarson, 0.96 per cent in karan rai and 0.71 per cent in taramira. The most important factor determining the extent of losses was the coincidence of peak flowering of cultivars with the peak aphid population. The studies revealed that the yield losses were greatly influenced in the different seasons and different *Brassica* species.

Key words: Avoidable yield losses, Rapeseed–Mustard, *Brassica*, Mustard aphid, *Lipaphis erysimi*

INTRODUCTION

The rapeseed–mustard is the third most important oilseed crop of India after soybean and groundnut and occupies 6.30 million hectare area with total production of 7.20 million tones with 1142 kg/ha productivity and Rajasthan is the leading state in India with total production of 3.50 million tons from 2.83 million hectare area and share 48.64 per cent of total production of rapeseed–mustard during 2008–09 (Anonymous 2010). Bakhetia (1987) reported that a total of 38 insect pests infesting the oilseed *Brassica* crops amongst them the mustard aphid (*Lipaphis erysimi* Kaltenbach) is the key pest of rapeseed–mustard crops in India. Mustard aphid is one of the major limiting factors in rapeseed–mustard production and its infestation starts at the vegetative phase but the major loss is caused during the reproductive phase. Bakhetia and Sekhon (1989) reported that in severe aphid infestation, plants wither resulting in low pod formation and thereby reduction in seed yield and oil content. The avoidable losses in seed yield of mustard due to aphid infestation have been reported from 26 to 96 % (Phadke 1980) and loss in oil content up to 15 % (Verma and Singh 1987). The reduction in yield has been related with an increase in the level of mustard aphid population (Gupta 1971, Singhvi *et al.* 1973, Bakhetia 1983, Singh *et al*., 1983 and Mishra and Singh 1986). Since Eastern Rajasthan is major mustard producing area of India, the study on avoidable yield losses due to mustard aphid in this region would provide the information and its importance for the development of sound strategies for the management. Therefore, the present investigation was undertaken to find out the avoidable yield losses caused by this dreaded pest in Eastern Rajasthan.

MATERIALS AND METHODS

The field experiments were conducted at the National Research Centre on Rapeseed–Mustard (Now Directorate

of Rapeseed Mustard Research), Sewar, Bharatpur during rabi season for ten consecutive years from 1996–97 to 2005–06 to study the avoidable yield losses due to the aphids associated with rapeseed–mustard (*Lipaphis erysimi* Kalt., *Brevicoryne brassicae* Linn. and *Myzus persicae* Sulzer). Among these aphid species, the major contribution was of mustard aphid (*L. erysimi*) and very low popualtion of *B. brassicae* and *M. persicae* was observed. Six oilseed *Brassica* crops *viz*., Indian mustard (*Brassica juncea* var. PCR–7/Varuna), Brown sarson (*Brassica campestris* var. BSH–1), Karan rai (*Brassica carinata* var. DLSC–2/BCNRC–1), Yellow sarson (*Brassica campestris* var. YST–151), Gobhi sarson (*Brassica napus* var. HYOLA–401/NUDB–09) and Taramira (*Eruca sativa* var. T–27) were taken for the study. The crop sown in Randomized Block Design (RBD) in the plot size of 4.2 x 3.0 m having at least 12 plots for each cultivar every year. Half of these plots were kept fully protected by spraying of oxy–demeton methyl @ 0.025 % at weekly interval and half were kept unprotected. All the recommended agronomic practices were followed to raise the good crop. The crop was sown 10–15 days delayed from the normal date of sowing to get the appropriate aphid infestation. During 1996–97 and 1997–98, only two *Brassica* species *i.e.* Indian mustard and brown sarson were evaluated and thereafter from 1998–99 to 2005–06 all the six *Brassica* species were observed for the avoidable yield losses. Ten plants were randomly selected and tagged from each plot and the aphid population was recorded on the 10 cm central shoot from the initiation of aphid infestation till the maturity of the crop at weekly interval and the average aphid infestation index (AAII) was calculated according to Bakhetia and Sandhu (1973). The yield data of each plot was taken and converted into kg/ha and the seed samples from each plot (Protected and unprotected) were collected and analyzed for their oil contents. The avoidable seed yield loss and loss in oil contents were calculated as per following formula.

$$\text{Per cent avoidable yield loss} = \frac{\text{Yield in protected plot} - \text{YIeld in unprotected plot}}{\text{Yield in protected plot}} \times 100$$

$$\text{Per cent loss in oil content} = \frac{\text{Oil content in protected plot} - \text{Oil content in unprotected plot}}{\text{Oil content in protected plot}} \times 100$$

RESULTS

The study was carried out for ten years to find out the avoidable yield losses due to mustard aphid in *Brassica* crops under field conditions from 1996–97 to 2005–06 and Average Aphid Infestation Index (AAII), Aphid population/plant, seed yield loss (%) and oil loss (%) in different oilseed *Brassicas* are presented in Table 1. The pooled mean of 10 years on AAII, Aphid population/plant, seed yield loss and oil loss is presented in Table 2.

Avoidable Seed yield and oil loss: The mustard aphid infestation was found very high during the year 1996–97 with the average aphid infestation index (AAII) of 4.63 in Indian mustard and 4.90 in brown sarson and the mean number of aphids per plant were recorded as 955.20 and 1125.4 in Indian mustard and brown sarson, respectively. The avoidable seed yield loss of 86.05 % and 90.11 % was recorded in Indian mustard and brown sarson respectively however the oil loss was found 8.19 % and 6.81 % in respective cultivars. During the year 1997–98, the mustard aphid infestation was recorded very high with the average aphid infestation index (AAII) of 4.86 in Indian mustard and 3.90 in brown sarson and the mean numbers of aphids per plant were recorded as 1048.3 and 760.40 in Indian mustard and brown sarson, respectively. The avoidable seed yield loss and oil loss of 90.97 % and 8.53 % were found in Indian mustard, respectively however in brown sarson 69.12 and 5.27 %, respectively. Due to the late appearance and multiplication of mustard aphid, brown sarson escaped the heavy infestation because of its short duration maturity period in comparison to the Indian mustard resulted in low avoidable seed yield loss. During the year 1998–99, the mustard aphid infestation was negligible having the mean aphid population as 22.6, 45.6, 35.7, 38.5, 2.1, and 3.1 in Indian mustard, brown sarson, yellow sarson, gobhi sarson, karan rai and taramira and yield loss of 3.10, 6.56, 5.33, 4.31, 0.38, and 0.40 respectively.

The aphid infestation was found moderate during the year 1999–00 with the AAII of 1.81, 2.36, 2.14, 2.07, 0.48 and 0.35 in Indian mustard, brown sarson, yellow sarson, gobhi sarson, karan rai and taramira, respectively and the mean numbers of aphids per plant were recorded as 220.5, 285.7, 187.6, 285.7, 25.2 and 23.5 in respective cultivars. In Indian mustard, brown sarson, yellow sarson, gobhi sarson, karan rai and taramira the avoidable seed yield loss of 19.85, 30.44, 26.04, 30.22, 5.83 and 2.17 % and oil loss of 3.36, 3.90, 2.95, 4.77, 0.75 and 0.37 % were found, respectively. During 2000–01, the mustard aphid infestation was found moderate towards the pod filling stage and lately attained severe form. The AAII as 2.15, 3.10, 2.80, 3.90, 2.10 and 1.25 were recorded in Indian mustard, brown sarson, yellow sarson, gobhi sarson, karan rai and taramira, respectively and the mean number of aphids per plant were found as 290.1, 386.2, 268.2, 806.5, 184.3, and 76.2 in respective cultivars. In Indian mustard, brown sarson, yellow sarson, gobhi sarson, karan rai and taramira, the avoidable seed yield loss of 30.23, 46.88, 47.36, 92.09, 28.83, and 8.25 % and oil loss of 3.46, 3.14, 3.01, 4.59, 2.67 and 2.84 % were found, respectively. Gobhi

Table 1. Average Aphid Infestation Index (AAII), Aphid population/plant, seed yield loss (%) and oil loss (%) in different oilseed *Brassicas* during 1996–97 to 2005–06

Years	Indian Mustard				Brown Sarson				Yellow Sarson			
	AAII	Aphid population /plant	Yield loss (%)	Oil loss (%)	AAII	Aphid population /plant	Yield loss (%)	Oil loss (%)	AAII	Aphid population /plant	Yield loss (%)	Oil loss (%)
1996–97	4.63	955.25	86.05	8.19	4.90	1125.36	90.11	6.81	*	*	*	*
1997–98	4.86	1048.33	90.97	8.53	3.90	760.42	69.12	5.27	*	*	*	*
1998–99	0.10	22.56	3.10	0.10	0.35	45.64	6.56	0.22	0.30	35.65	5.33	0.23
1999–00	1.81	220.54	19.85	3.36	2.36	285.65	30.44	3.90	2.14	187.55	26.04	2.95
2000–01	2.15	290.12	30.23	3.46	3.10	386.24	46.88	3.14	2.80	268.15	47.36	3.01
2001–02	1.87	148.65	15.89	2.95	2.90	365.45	37.79	1.20	1.65	168.70	21.15	0.90
2002–03	1.35	155.32	19.72	1.50	2.70	296.58	30.22	2.39	2.80	341.25	34.89	2.65
2003–04	1.13	131.76	9.37	2.33	1.70	145.25	18.58	3.04	1.30	86.18	10.65	0.80
2004–05	1.30	145.24	15.55	1.51	3.20	381.32	31.62	3.32	2.80	227.73	28.16	2.92
2005–06	1.89	107.26	9.25	0.66	2.46	164.25	17.68	1.97	2.58	215.34	16.88	1.20
SEM ±	–	–	2.67	1.06	–	–	3.45	1.12	–	–	3.76	0.86
C.D. (P = 0.05	–	–	8.23	3.18	–	–	10.52	3.26	–	–	11.29	2.49

Continued...

Years	Gobhi Sarson				Karan Rai				Taramira			
	AAII	Aphid population /plant	Yield loss (%)	Oil loss (%)	AAII	Aphid population /plant	Yield loss (%)	Oil loss (%)	AAII	Aphid population /plant	Yield loss (%)	Oil loss (%)
1996–97	*	*	*	*	*	*	*	*	*	*	*	*
1997–98	*	*	*	*	*	*	*	*	*	*	*	*
1998–99	0.27	38.45	4.31	0.33	0.08	2.12	0.38	0.02	0.03	3.14	0.4	0.03
1999–00	2.07	285.65	30.22	4.77	0.48	25.23	5.83	0.75	0.35	23.45	2.17	0.37
2000–01	3.90	806.47	92.09	4.59	2.10	184.26	28.83	2.67	1.25	76.18	8.25	2.84
2001–02	1.90	210.10	23.50	1.20	0.90	45.12	9.83	1.02	0.63	15.13	5.39	0.28
2002–03	2.65	275.15	29.39	2.32	0.65	14.95	6.93	0.77	0.30	7.57	3.55	0.76
2003–04	1.60	136.46	16.46	1.18	0.27	10.59	6.68	0.72	0.10	2.46	6.95	0.17
2004–05	3.80	315.14	35.70	3.64	0.15	71.85	10.34	0.90	0.18	53.67	10.73	0.85
2005–06	2.84	295.15	21.08	2.21	0.10	56.96	10.91	0.80	0.13	37.93	7.46	0.35
SEM ±	–	–	3.96	1.07	–	–	1.89	0.47	–	–	1.13	0.28
C.D. (P = 0.05	–	–	11.89	3.21	–	–	5.69	1.43	–	–	3.39	0.83

* Not sown in the year 1996–97 and 1997–98

Table 2. Pooled mean of Average Aphid Infestation Index (AAII), Aphid population/plant, seed yield loss (%) and oil loss (%) in different oilseed *Brassicas* during 1996–97 to 2005–06

Brassica species	AAII	Aphid population /plant	Yield loss (%)	Oil loss (%)
Indian Mustard	2.11	322.50	29.99	1.98
Brown Sarson	2.76	395.62	37.90	3.12
Yellow Sarson	2.05	191.32	23.81	1.83
Gobhi Sarson	2.38	295.32	31.59	2.53
Karan Rai	0.59	51.39	9.97	0.96
Taramira	0.37	27.44	5.61	0.71
SEM ±	–	–	2.32	0.12
C.D. (P = 0.05	–	–	6.97	0.38

sarson suffered the highest yield loss due to its late maturity and longer persistence of mustard aphid due to favourable weather conditions. During 2001–02, the AAII of 1.87, 2.90, 1.65, 1.90, 0.90 and 0.63 were recorded in Indian mustard, brown sarson, yellow sarson, gobhi sarson, karan rai and taramira, respectively and the mean number of aphids per plant as 148.7, 365.5, 168.7, 210.1, 45.1 and 15.1 in respective cultivars. In Indian mustard, brown sarson, yellow sarson, gobhi sarson, karan rai and taramira, the avoidable seed yield loss of 15.89, 37.79, 21.15, 23.50, 9.83 and 5.39 % and oil loss of 2.95, 1.20, 0.90, 1.20, 1.02 and 0.28 % were found, respectively.

During 2002–03, the mustard aphid infestation was found moderate and the AAII of 1.35, 2.70, 2.80, 2.65, 0.65 and 0.30 were recorded in Indian mustard, brown sarson, yellow sarson, gobhi sarson, karan rai and taramira, respectively and the mean number of aphids per plant as 155.3, 296.6, 341.3, 275.2, 15.0 and 7.6 in respective cultivars. In Indian mustard, brown sarson, yellow sarson, gobhi sarson, karan rai and taramira the avoidable seed yield loss of 19.72, 30.22, 34.89, 29.39, 6.93 and 3.55 % and oil loss of 1.50, 2.39, 2.65, 2.32, 0.77 and 0.76% were found, respectively. The aphid infestation was found very low during the year 2003–04 with the AAII of 1.13, 1.70, 1.30, 1.60, 0.27 and 0.10 were found in Indian mustard, brown sarson, yellow sarson, gobhi sarson, karan rai and taramira, respectively and the mean number of aphids per plant as 131.8, 145.3, 86.2, 136.5, 10.6 and 2.7 in respective cultivars. In Indian mustard, brown sarson, yellow sarson, gobhi sarson, karan rai and taramira, the avoidable seed yield loss of 9.37, 18.58, 10.65, 16.46, 6.68 and 6.95% and oil loss of 2.33, 3.04, 0.80, 1.18, 0.72 and 0.17% were recorded, respectively. During 2004–05, the mustard aphid infestation was found moderate and AAII of 1.30, 3.20, 2.80, 3.80, 0.15 and 0.18 in Indian mustard, brown sarson, yellow sarson, gobhi sarson, karan rai and taramira were recorded, respectively and the mean number of aphids per plant was recorded as 145.24, 381.32, 227.73, 315.14, 71.85 and 53.67 in respective cultivars. In Indian mustard, brown sarson, yellow sarson, gobhi sarson, karan rai and taramira, the avoidable seed yield loss of 15.55, 31.62, 28.16, 35.70, 10.34 and 10.73% and oil loss of 1.51, 3.32, 2.92, 3.64, 0.90 and 0.85 % were found, respectively. During 2005–06, the mustard aphid infestation was found moderate and AAII of 1.89, 2.46, 2.58, 2.84, 0.10 and 013 in Indian mustard, brown sarson, yellow sarson, gobhi sarson, karan rai and taramira were recorded, respectively and the mean number of aphids per plant was recorded as 107.26, 164.25, 215.34, 295.15, 56.96 and 37.93 in respective cultivars. In Indian mustard, brown sarson, yellow sarson, gobhi sarson, karan rai and taramira, the avoidable seed yield loss of 9.25, 17.68, 16.88, 21.08, 10.91 and 7.46% and oil loss of 0.66, 1.97, 1.20, 2.21, 0.80 and 0.35% were found, respectively.

Mean avoidable seed yield and oil loss: The mean of pooled data for ten years revealed that the mean AAII were found as 2.11, 2.76, 2.05, 2.38, 0.59 and 0.37 in Indian mustard, brown sarson, yellow sarson, gobhi sarson, karan rai and taramira and the mean aphid population per plant as 322.50, 395.62, 191.32, 295.32, 51.39 and 27.44 in respective cultivars. The mean yield losses in these respective cultivars were found as 29.99, 37.90, 23.81, 31.59, 9.97 and 5.61 % and mean oil loss of 1.98, 3.12, 1.83, 2.53, 0.96 and 0.71 %, respectively.

DISCUSSION

It was observed that the mustard aphid appearance and multiplication depends upon the weather conditions that lead to the yield loss in rapeseed–mustard. The *Brassica* cultivars also showed fair resistance/tolerance to the pest as clear from the AAII, aphid population, yield loss and oil loss. Karan rai and taramira had the low yield loss and also showed the high degree of resistance/ tolerance to the pest along with Indian mustard in some years of study in comparison to other *Brassica* species. The yield also found to be dependent upon the crop maturity period as the aphid appeared early, the early maturing crop like brown sarson and yellow sarson suffered more while in late appearance of aphid and suitable weather conditions, the late maturing cultivars like gobhi sarson suffered very high yield losses.

The present findings are in accordance with Prasad (1995) reported that the loss in seed yield differed not only varieties but also in the same variety in different years that is due to variable weather conditions in different years. Rapeseed–mustard crop varieties were found to suffer a yield loss ranging from 8.9 to 77.5 % due to aphid attack at Delhi (Prasad and Phadke 1984). Sharma and Kashyap

(1998) reported 62.51 % yield loss in brown sarson (var. BSH–1) and 50 % in Indian mustard (Var. Varuna). Suri *et al*. (1988) also observed 42.1 % yield losses in brown sarson in Himachal Pradesh. Yield loss in some of the promising varieties of Indian mustard was estimated to range from 16.3 to 52.5 % (Phadke and Prasad 1984). Verma and Singh (1987) found the yield losses due to mustard aphid ranging from 90 to 93 % in Mustard in Madhya Pradesh. Singh and Sachan (1994) also reported the avoidable losses due to mustard aphid up to 69.6 %. Bakhetia (1979) reported that the yield losses ranging from 66 to 95 % in *Brassica campestris* and from 27 to 68 % in *Brassica juncea*. Brar *et al.* (1987) reported yield losses ranging from 35.4 to 91.3 % due to mustard aphid while Patel *et al.* (2004) observed that yield loss varied from 76.0 to 92.7 % in 1995–96, 81.5 to 100.0 %in 1996–97 and 84.4 to 100.0 % in 1997–98 in Indian mustard showing similarity to our findings in respective years. The infestation of mustard aphid resulted up to 90 % losses in seed yield and 5 % reduction in oil content of rapeseed–mustard crops (Singhvi *et al*. 1973; Bakhetia 1987; Singh *et al*. 1987; Rohilla *et al.* 1987). Peshwani *et al.* (1968) reported that the mustard aphid incidence resulted in 10 % losses in oil content of *Brassica* crops while Rohilla (2000) reported from 6 to 10 %. Verma and Singh (1987) reported the oil loss up to 15 % in case of severe infestation of mustard aphid. These results are also in the corroboration with the present study. The variations in the avoidable yield losses may be attributed to the different level of aphid infestation during different years of studies and varied agro–climatic zones/different agro–ecological conditions and made necessary to develop effective, economic and eco–friendly management of the pest.

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