


Research Article

## Management of powdery mildew and aphid in organically grown Indian mustard (*Brassica juncea* L.) through different oils

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### Abstract

All the cultivated *Brassica* species exhibited powdery mildew severity with highest (43.2%) on *Brassica juncea* followed by *B. rapa* (28.0%) which is widely cultivated in India. Yield losses from 10-90 per cent with reduction in 6.47 per cent oil content have been estimated from different *Brassica* species. Hence, the present study was carried out to evaluate different oils to manage powdery mildew disease and aphids in an organically grown mustard crop. Five oils (castor, groundnut, sunflower, neem and mustard oil) and *ghee* were evaluated against powdery mildew (*Erysiphae cruciferarum*) and aphid (*Lipaphis erysimi*) of Indian mustard (*Brassica juncea*). Castor oil 50 EC, neem oil 50 EC and mustard oil 50 EC and *deshi ghee* 50 EC (@ 100 ml/10 litre water) were effective over untreated control in reducing powdery mildew disease severity when applied as foliar spray (@ 5 ml/litre) in the experiment carried out in organic field (plot No. B-2 at Agronomy Instruction Farm, S. D. Agricultural University, Sardaradarkrushinagar). Maximum reduction in germinated conidia (66.0%) over control, disease severity (50.0%), area under disease progress curve (AUDPC) values (51.8%) and maximum increase over control in 1000 seed weight (16.7%) and seed yield (10.3%) was observed with neem oil. This was followed by the application of *ghee* which exhibited reduced disease severity (22.9%) and AUDPC values (30.6%) and increased seed yield (8.1%) and the application of castor oil 50 EC which exhibited an increased in seed yield (8.0%) and reduced powdery mildew severity (20.8%). Shortest log phase was observed with neem oil during 10<sup>th</sup> std. week. All the oils tested (castor, groundnut, sunflower, neem and mustard oil) and *deshi ghee* were effective in reducing aphid population (39.5 to 65.9%) and damage index (6.1 to 25.1%). A maximum reduction in aphid population (65.9%) over control and lowest aphid damage index (3.70) was observed with neem oil 50 EC 6 days after 2<sup>nd</sup> spray. Application of neem oil, castor oil and *deshi ghee* resulted in increased seed yield (8.1 to 10.4%). This information could be useful in devising strategies for powdery mildew and aphid management in organic cultivation, eco-friendly management and IPM of mustard.

**Keywords:** Conidial germination, Disease severity, Mustard aphid, Oils, Organic cultivation, Powdery mildew, Under disease progress curve

### INTRODUCTION

Indian mustard *Brassica juncea* (L.) Czern&Coss is the most important oilseed crop in India, next to groundnut grown under wide range of agro-climatic conditions (Devi, 2018). Among the Oilseed crops, *Brassica* spp. plays a pivotal role in Indian agricultural economy. Various biotic and abiotic stresses are causing considerable yield losses to rapeseed and mustard crop. Among biotic stresses, the damage caused by plant diseases is one of the major constraints. All above ground plant

part are affected with powdery mildew (*Erysiphae cruciferarum*) which can cause heavy yield losses and poor quality of seeds particularly on late sown crops. Powdery mildew on mustard is distributed in more than 25 countries of the world infecting more than 125 crucifers host plants including vegetable and oil yielding economically important crops (Meena *et al*, 2018). The disease has been reported from 17 states in India. Distribution and severity of powdery mildew disease was recorded from Gujarat (57.5%), Maharashtra (38.7%), Punjab (30.8%), Uttar Pradesh (30.1%), Manipur

(39.4%), Madhya Pradesh (21.5%), Haryana (20.6%), Chhattisgarh (25.5%), Uttarakhand (24.5%), Rajasthan (22.1%), Delhi (20.0%), Bihar (15.5%), Jharkhand (20.0%), Assam (15.0%), Tamil Nadu (35.0%), Jammu and Kashmir (10.0%), Himachal Pradesh (5.0%) and other mustard growing areas of the countries (Anonymous, 2000-2017, Meena *et al.*, 2018). Mustard powdery mildew has been reported to cause yield losses to the tune of 24.10 per cent under North Gujarat conditions (Dange *et al.*, 2002).

Mustard aphid is the major constraint responsible for low yield as well as low quality seed, which is considered as key factor in reducing mustard production and sometime it is so severe that may cause yield loss up to 90.0% in *Brassica carinata* (Gupta *et al.*, 2003). The yield loss due to aphid (*Lipaphis erysimi*) infestation in mustard (*B. juncea*) ranged from 76.0 to 100.0% under delayed sowing (18 Dec.) without proper and timely plant protection and failed to survive (Patel *et al.*, 2004). The present study was carried out to evaluate different oils for the manage powdery mildew disease and aphid in organically grown mustard crop.

## MATERIALS AND METHODS

### Experimental detail

Field experiments were carried out for inorganic farming plot (No. B-2) at Agronomy Instruction Farm at S. D. Agricultural University, Sardarkrushinagar (Gujarat) during *Rabi* 2021-22, which is situated at an altitude of 152.52 meters above mean sea level on 24° – 19' N latitude and 72° – 19' E longitude. The mustard variety 'GDM-4' was late sown in the month of November to ensure higher disease pressure. It was sown with a spacing of 45 cm × 15 cm (5 rows of 5 m length) with 2.25 m × 5.00 m gross plot following Randomized Block Design. The experiment was late sown on 22<sup>th</sup> November 2021 to ensure higher powdery mildew and aphid pressure. No chemical fertilizers, application of FYM @ 10 t/ha, and three hand weeding were carried out to raise a good organic mustard crop. All the observations were recorded in a net plot (1.35 m × 4.00).

### Treatment details

Different oils (castor, groundnut, sunflower, neem and mustard oil) and *deshi ghee* 50% EC (Emulsified Concentration) were applied as foliar spray @ 10 ml/litre. To prepare spray solution of different oils, equal amounts of Tween 20 and oil (1,1 v/v) were mixed / homogenized for over 5 min. The oils and *ghee* were emulsified with equal quantity (v/v) of Tween 20 as a 50 % EC standard solution (Reuveni *et al.*, 1996, Terzi *et al.*, 2007). The 100 ml emulsified oil solution was diluted with 10 litres of water and applied twice as foliar spray at 7 days interval. First spray was applied at the time of disease appearance.

### Calculation of powdery mildew disease

Observation of powdery mildew disease severity (%), Area Under Disease Progress Curve (AUDPC), 1000 seed weight (g) and seed yield (kg/ha) were recorded. Powdery mildew severity was recorded as per cent infected area under disease. Disease severity was recorded on Tuesday morning and Friday evening, starting from the appearance of disease. The Disease Progress Curve (DPC) was prepared by plotting the disease severity of different treatments against time. The AUDPC was calculated by using the formula given by Shaner and Finney (1977).

$$AUDPC = \sum_{i=1}^n [(x_i + x_{i+1}) \times t_i] / 2 \quad \text{Eq.1}$$

Where,

$X_i$  and  $X_{i+1}$  are severities on date  $i$  and date  $i+1$ , respectively

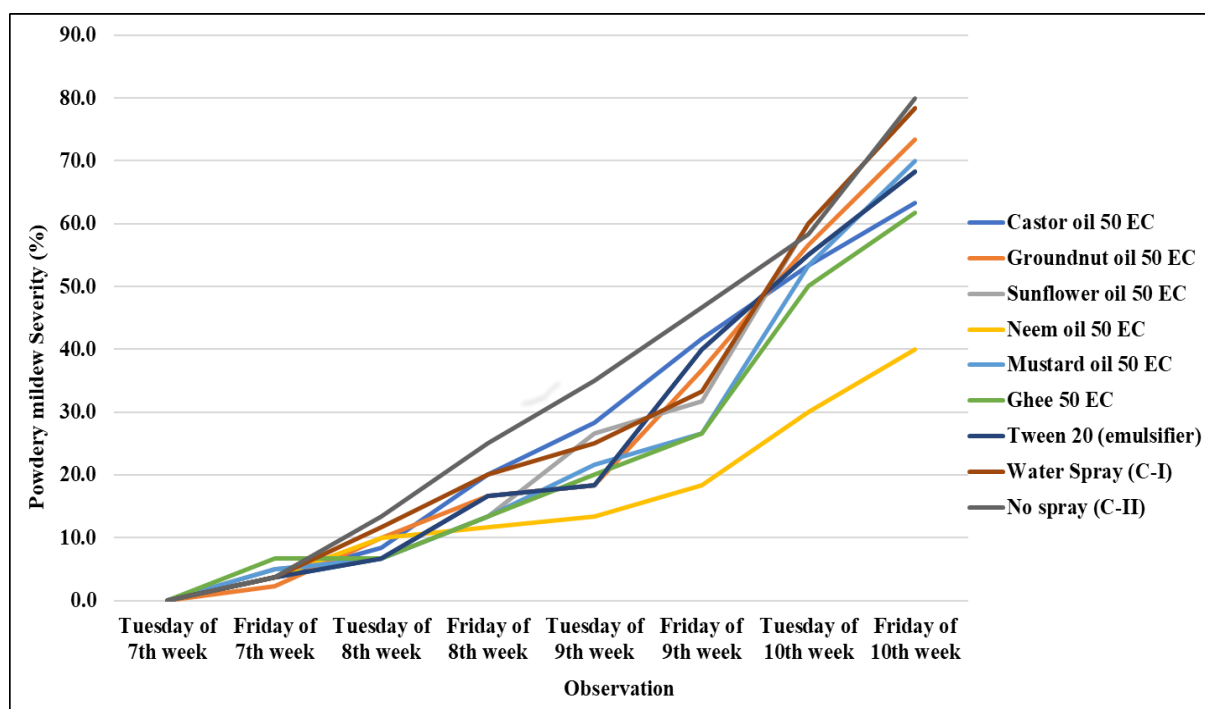
$t_i$  = the number of days in between date  $i$  and date  $i+1$

$n$  = the number of observations recorded.

### Record of observations on mustard aphid

Observation on aphid population index (API) and Aphid damage index (ADI) was recorded on randomly tagged

Grade	Aphid Population Index (API)	Aphid Damage Index (ADI)
1	No or less than 20 aphids on the inflorescences of test plants	Normal plant growth, no symptoms of injury, no curling or yellowing of leaves
2	Up to 25 % inflorescences have 21-100 aphids on the test plants	Average plant growth, curling and yellowing of few leaves, flowering and fruiting
3	Up to 50 % of inflorescences have 101-250 aphids across test plants	Poor plant growth, curling and yellowing of leaves on some branches, drying of few flowers and poor pod setting
4	Up to 75 % inflorescences have 251-500 aphids across test plants	Stunted plant growth, heavy curling and yellowing of leaves all through the plant, drying and curling of almost half the inflorescence with poor flowering and rare pod setting
5	100 % of inflorescences have more than 500 aphids across test plants	Severe stunting and ragged plant appearance, yellowing and curling of almost all the leaves, complete drying of inflorescence without any flower and immature drying of pods if any



**Fig. 1.** Effect of foliar application of oils on the progress of powdery mildew diseases severity, under organic field conditions (Rabi, 2021-22)

10 plants as per the following scale (Dhillon *et al.*, 2018),

#### Data analysis

Statistical analysis of the data obtained from the experiments was done using appropriate programme as per the requirement of the experiment. The critical difference (CD) was calculated at 5% level of significance for comparison of the difference between the means of different treatments.

## RESULTS AND DISCUSSION

#### Effect on powdery mildew disease

Different oils (castor, groundnut, sunflower, neem and mustard oil) and *deshi ghee* applied as foliar spray significantly reduced powdery mildew diseases severity (Table 1). Results revealed that minimum disease severity (40.0%) was observed with foliar application of neem oil 50 EC followed by *deshi ghee* 50 EC (61.7%) and castor oil 50 EC (63.3%). However, the powdery mildew disease severity observed with other oils *viz.*, groundnut oil 50 EC (73.3%), mustard oil 50 EC (70.0%), castor oil 50 EC (63.3%) and *deshi ghee* 50 EC (61.6%) were statistically similar to emulsifier (68.3%) used for the preparation of formulation (Tween 20). The effect of foliar application of oils on the progress of powdery mildew diseases severity was observed at 3.5 days interval starting from appearance of disease till the maturity of crop. Disease severity was recorded on every Tuesday morning and Friday even-

ing. Lag phase was observed from Tuesday morning of 7<sup>th</sup> std. week to the Tuesday morning of 8<sup>th</sup> week in most of the treatments (Fig. 1). However, extended lag phase from Tuesday morning of 7<sup>th</sup> std. week to Friday evening of 9<sup>th</sup> std. week was observed with application of neem oil and shortest lag phase was observed with neem oil during 10<sup>th</sup> std. week. Extended lag phase was also observed with control, water spray and castor oil which were started on Friday evening of 8<sup>th</sup> std. week to Friday evening of 10<sup>th</sup> std. week. Effect of oils and *deshi ghee* applied as foliar spray on area under disease progress curve (AUDPC) was significant. Minimum AUDPC values (53.5 unit) was observed with neem oil 50 EC. However, AUDPC values observed with groundnut oil 50 EC (88.7 unit), sunflower oil 50 EC (91.3 unit), mustard oil 50 EC (80.8 unit), castor oil 50 EC (93.5 unit) were statistically similar to emulsifier (87.3 unit) used for preparation of formulation (Tween 20). AUDPC value obtained with water spray (96.4 unit) was significantly lower as compare to no spray (111.0 unit). The differences in 1000 seed weight of mustard significantly varied among the treatment. The 1000 seed weight recorded with all the oils and *ghee*, neem oil 50 EC (4.90 g), castor oil 50 EC (4.84 g), mustard oil 50 EC (4.38 g), *deshi ghee* 50 EC (4.39 g), groundnut oil 50 EC (4.29 g), and sunflower oil 50 EC (4.23 g) were statistically equal to emulsifier (4.56 g) used for preparation of formulation (Tween 20). However, 1000 seed weight recorded with neem oil 50 EC (4.90 g) and castor oil 50 EC (4.84 g) were statistically higher as compare to no spray (4.20 g). The differ-

**Table 1.** Efficacy of foliar application of different oils against powdery mildew disease of mustard, under organic field conditions (2021-22)

S. No.	Treatments	PM disease severity (%)	Decrease in disease severity over control (%)	AUDPC (Units)	Decrease in AUDPC over control (%)	1000 Seed weight (gm)	Increase in 1000 Seed weight over control (%)	Yield (kg/ha)	Increase in yield over control (%)
1.	Castor oil 50 EC	63.3 <sup>b</sup> (52.8)	20.8	654.5 <sup>bc</sup>	15.8	4.84 <sup>ab</sup>	15.2	889.8	8.1
2.	Groundnut oil 50 EC	73.3 <sup>ab</sup> (58.9)	8.3	620.7 <sup>bcd</sup>	20.1	4.29 <sup>c</sup>	2.1	877.2	6.6
3.	Sunflower oil 50 EC	78.3 <sup>a</sup> (62.3)	2.1	638.8 <sup>bc</sup>	17.8	4.23 <sup>c</sup>	0.8	875.4	5.8
4.	Neem oil 50 EC	40.0 <sup>c</sup> (39.2)	50.0	374.5 <sup>e</sup>	51.8	4.90 <sup>a</sup>	16.7	908.6	10.4
5.	Mustard oil 50 EC	70.0 <sup>ab</sup> (56.8)	12.5	565.8 <sup>cd</sup>	27.2	4.38 <sup>bc</sup>	4.5	849.9	2.7
6.	Ghee 50 EC	61.7 <sup>b</sup> (51.8)	22.9	539.6 <sup>d</sup>	30.6	4.39 <sup>bc</sup>	4.6	891.0	8.3
7.	Tween 20 (emulsifier)	68.3 <sup>ab</sup> (56.1)	14.6	610.8 <sup>bcd</sup>	21.4	4.56 <sup>abc</sup>	8.6	882.0	6.8
8.	Water Spray (C-I)	78.3 <sup>a</sup> (62.3)	2.1	674.9 <sup>b</sup>	13.1	4.23 <sup>c</sup>	0.8	836.9	1.7
9.	No spray (C-II)	80.0 <sup>a</sup> (63.5)	-	777.0 <sup>a</sup>	-	4.20 <sup>c</sup>	-	824.0	-
<b>S. Em. ±</b>		4.0	-	28.1	-	0.14	-	39.7	-
<b>C. D. at 5%</b>		12.0	-	60.1	-	0.41	-	NS	-
<b>C.V. %</b>		10.1	-	5.7	-	5.29	-	7.9	-

\*NS= non-significant, Mean of three replications, Figures in parentheses are arcsintransformed values and outside are original value. Treatment means with the common letters(s) are not significantly by Duncan's New Multiple Range Test at 5% level of significance

**Table 2.** Effectiveness of different oils against mustard aphid population index in mustard, under organic field condition (2021-22)

S. No.	Treatments	No. of aphid/10 cm apical shoot						
		First spray		Second spray				
	1DBS	3 DAS	6 DAS	3 DAS	6 DAS	% Reduction	% Reduction	
1.	Castor oil 50 EC	27.2 (740.1)	24.7 <sup>b</sup> (610.5)	21.0 <sup>de</sup> (440.7)	22.5 <sup>b</sup> (504.4)	19.7 <sup>e</sup> (388.8)	54.2	47.6
2.	Groundnut oil 50 EC	26.8 (718.9)	25.4 <sup>b</sup> (643.7)	22.6 <sup>cd</sup> (508.6)	23.2 <sup>b</sup> (538.1)	22.2 <sup>cd</sup> (493.7)	47.1	44.1
3.	Sunflower oil 50 EC	27.2 (741.5)	25.4 <sup>b</sup> (646.5)	20.9 <sup>de</sup> (435.0)	23.4 <sup>b</sup> (548.7)	23.0 <sup>c</sup> (526.9)	54.8	43.0
4.	Neem oil 50 EC	27.8 (774.9)	24.7 <sup>b</sup> (610.6)	20.9 <sup>de</sup> (436.3)	22.6 <sup>b</sup> (507.8)	17.2 <sup>f</sup> (296.4)	54.6	47.3
5.	Mustard oil 50 EC	27.3 (745.1)	25.3 <sup>b</sup> (640.0)	18.5 <sup>e</sup> (340.1)	23.1 <sup>b</sup> (534.4)	21.5 <sup>cde</sup> (459.8)	64.6	44.5
6.	Ghee 50 EC	27.8 (772.9)	24.8 <sup>b</sup> (616.1)	23.4 <sup>cd</sup> (548.0)	22.8 <sup>b</sup> (517.3)	19.9 <sup>de</sup> (396.0)	43.0	46.3
7.	Tween 20 (emulsifier)	27.6 (760.8)	25.0 <sup>b</sup> (623.6)	24.2 <sup>bc</sup> (584.6)	22.8 <sup>b</sup> (518.2)	20.0 <sup>de</sup> (399.1)	39.3	46.2
8.	Water Spray (C-I)	27.3 (745.3)	29.5 <sup>a</sup> (867.9)	26.7 <sup>b</sup> (709.9)	29.4 <sup>a</sup> (862.4)	25.3 <sup>b</sup> (641.3)	26.2	10.5
9.	No spray (C-II)	27.1 (735.1)	31.2 <sup>a</sup> (970.3)	31.0 <sup>a</sup> (961.6)	31.0 <sup>a</sup> (963.4)	29.5 <sup>a</sup> (870.4)	-	-
<b>S. Em. ±</b>		55.1	44.5	36.3	52.5	26.8	-	-
<b>C. D. at 5%</b>		N.S.	134.7	109.7	158.8	81.0	-	-
<b>C.V. %</b>		12.6	11.1	11.4	14.8	9.3	-	-

\* DBS, Days before Spray, DAS, Days after Spray, Figures in parentheses are retransformed values, while those outside are  $\sqrt{X} \pm 0.5$  transformed values. Treatment means with the common letters(s) are not significant by Duncan's New Multiple Range Test at 5% level of significance

ences in seed yield of mustard were non-significant varied among the treatment. However, comparatively higher seed yield (908.6 kg/ha) was recorded with neem oil 50 EC which was followed by *ghee* 50 EC (891.0 kg/ha) and castor oil 50 EC (889.8 kg/ha).

Kumar and Chandel (2018) obtained the highest efficacy with *Bacillus subtilis*, neem oil and *Allium sativus* at their higher concentrations under *in vitro* studies of powdery mildew of rose. Hoque *et al.* (2013) observed that mustard oil (0.5%) and neem oil (0.5%) significantly decreased the severity of the powdery mildew disease of jujube. Mishra *et al.* (2017) reported the efficacy of neem leaves extract, neem oil, eucalyptus leaves extract, *Trichoderma harzianum*, *Pseudomonas fluorescens* and hexaconazole against powdery mildew disease of garden pea where minimum per cent disease incidence (31.80%) and maximum pod yield (12.6 q/ha) was found with neem oil. Similarly, In the present study, maximum reduction over control in disease severity (50.0%), AUDPC values (51.8%), and maximum increase over control in 1000 seed weight (16.7%) and seed yield (10.3%) were observed with neem oil. This was followed by application of *deshi ghee* which exhibited reduced disease severity (22.9%) and AUDPC values (30.6%) and increased seed yield (8.1%) over control and application of castor oil 50 EC exhibited an increased in seed yield (8.0%) and reduced powdery mildew severity (20.8%) over control. Shortest log phase was observed with neem oil during 10<sup>th</sup> std. week. Several workers recorded similar observations with powdery mildew of different crops as neem oil and NSKE on *Abelmoschus esculentus* (Raghupathi *et al.*, 1997), sunflower oil on tomato (Ko *et al.*, 2003), citronella oil and neem oil on *Nephelium lappaceum* (Alahakoon *et al.*, 2010), neem oil on okra

(Moharamand Ali, 2012) and garlic extract and neem oil on ber (Choudhary *et al.*, 2020).

### Effect on mustard aphid

To find out the effectiveness against mustard aphid, periodical data on its population was recorded and is given in Table 2. The population of aphids were homogeneous in all treatment before spray (non-significant). All the evaluated treatment were significantly superior to untreated control up to 6 days after both sprays. All oils tested and *deshi ghee* was found significant in reducing aphid population in mustard one day after spray. The lowest population (610 aphid/10 cm twig) at 3 days after first spray was observed with application of neem oil 50 EC which was statistically equal to castor oil 50 EC (610.5 aphid/10 cm twig), *ghee* 50 EC (616.1 aphid/10 cm twig), emulsifier (623.6 aphid/10 cm twig), mustard oil 50 EC (640.0 aphid/10 cm twig), groundnut oil 50 EC (643.7 aphid/10 cm twig) and sunflower oil 50 EC (646.5 aphid/10 cm twig). Significantly, the lowest aphid population (340.1 aphid/10 cm twig) at 6 days after the first spray was observed in mustard oil 50 EC followed by sunflower oil 50 EC (435.0 aphid/10 cm twig), neem oil 50 EC (436.3 aphid/10 cm twig) and castor oil (440.7 aphid/10 cm twig). The lowest aphid population (504.4 aphid/10 cm twig) at 3 days after the second spray was observed with the application of castor oil 50 EC which was statistically similar to neem oil 50 EC (507.8 aphid/10 cm twig), *deshi ghee* 50 EC (517.3 aphid/10 cm twig), emulsifier (518.2 aphid/10 cm twig), mustard oil 50 EC (534.4 aphid/10 cm twig), groundnut oil 50 EC (538.1 aphid/10 cm twig) and sunflower oil 50 EC (548.7 aphid/10 cm twig). The lowest aphid population (296.4 aphid/10 cm twig) at 6 days after 2<sup>nd</sup> spray was observed in neem oil 50 EC fol-

**Table 3.** Effectiveness of foliar application of oils against mustard aphid damage index at 6 days after 2<sup>nd</sup> spray, under organic field conditions (2021-22)

S. No.	Treatments	Aphid Damage Index	% Reduction
1.	Castor oil 50 EC	4.10 <sup>bc</sup>	17.0
2.	Groundnut oil 50 EC	4.47 <sup>ab</sup>	9.5
3.	Sunflower oil 50 EC	4.63 <sup>ab</sup>	6.1
4.	Neem oil 50 EC	3.70 <sup>c</sup>	25.1
5.	Mustard oil 50 EC	4.33 <sup>b</sup>	12.2
6.	<i>Ghee</i> 50 EC	4.07 <sup>bc</sup>	17.6
7.	Tween 20 (emulsifier)	4.07 <sup>bc</sup>	17.6
8.	Water Spray (C-I)	4.67 <sup>ab</sup>	5.6
9.	No spray (C-II)	4.93 <sup>a</sup>	-
<b>S. Em.±</b>		0.17	-
<b>C. D. at 5%</b>		0.53	-
<b>C.V. %</b>		6.98	-

Treatment means with the common letters(s) are not significant by Duncan's New Multiple Range Test at 5% level of significance



lowed by mustard oil 50 EC (388.8 aphid/10 cm twig) and *ghee* 50 EC (396.0 aphid/10 cm twig). Effect of oils and *deshi ghee* applied as foliar spray on aphid damage index was significant (Table 3). The lowest aphid damage index (3.70 aphid index) was observed with neem oil 50 EC applications. This was followed by application of *deshi ghee* 50 EC and emulsifier where 4.07 aphid damage index was recorded at 6 days after 2<sup>nd</sup> spray.

Dotasara *et al.* (2017) observed that maximum aphid population reduction (73.9%) over control was found with neem oil 2 % @ 2.0 ml/litre against mustard aphid on cauliflower and they provided safety to coccinellid population/predators, which can be utilized in integrated pest management (IPM) programme. In the present study, maximum aphid population reduction (37.1%) over control at 3 days after first spray was observed with neem oil 50 EC and castor oil 50 EC (37.1%). This was followed by *ghee* 50 EC where 36.5 % reduction over control was recorded. Maximum aphid population reduction (64.6%) over control at 6 days after first spray was observed with mustard oil 50 EC followed by sunflower oil 50 EC (54.8%) and neem oil 50 EC (54.6%) at 6 days after 1st spray. Maximum aphid population reduction (47.6%) over control at 3 days after second spray was observed with castor oil 50 EC followed by neem oil 50 EC (47.3%) and mustard oil 50 EC (44.5%) at 3 days after 2<sup>nd</sup> spray. Maximum aphid population reduction (65.9%) over control at 6 days after second spray was observed with neem oil 50 EC followed by *ghee* 50 EC (54.5%) and emulsifier (54.2%) at 6 days after 2<sup>nd</sup> spray. Maximum aphid damage index (25.1%) over control was observed with neem oil 50 EC. This was followed by application of *ghee* 50 EC and emulsifier where 17.6 % reduction over control was recorded. Similarly, Singh and Lal (2009) found that neem seed kernel extract @ 5%, neem leaf extract @ 5% and neem oil @ 2% effectively reduced the mustard aphid population.

## Conclusion

Castor oil 50 EC, neem oil 50 EC and mustard oil 50 EC and *deshi ghee* 50 EC (@ 100 ml/10 litre water) were effective in reducing (12.5 to 50.0%) powdery mildew disease severity, in organically grown mustard (Var. GDM-4) crop when applied as two foliar spray at 7 days interval. All the oils tested (castor, groundnut, sunflower, neem and mustard oil) and *deshi ghee* were effective in reducing aphid population (39.5 to 65.9%) and damage index (6.1 to 25.1%). Application of neem oil, castor oil and *deshi ghee* resulted in increased seed yield (8.1 to 10.4%). However, neem oil was superior to all other treatments. Further study is required on large-scale organic mustard cultivation.

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## Conflict of interest

The authors declare that they have no conflict of interest.

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