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Bio-efficacy of various Botanical Insecticides against Mustard Aphid, *Lipaphis erysimi* Kalt

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ABSTRACT: The experiments were conducted during *Rabi* season 2020-2021 and 2021-2022 at Student Instructional farm (SIF) of department of Agronomy, Chandra Shekhar Azad University of Agriculture and Technology, Kanpur, Uttar Pradesh to evaluate the eco-friendly management of mustard aphid, *L. erysimi* Kalt. on mustard crop. Field experiments were laid out in a randomized block design (RBD) with 3 replications and 8 treatments. The treatments were *neem* leaf extract @ 5% 50 ml/L., T₂ Black pepper extract @ 5% 50 ml/L., T₃ *datura* leaf extract @ 5% 50 ml/L., T₄ eucalyptus leaf extract @ 5% 50 ml/L., T₅ papaya leaf extract @ 5% 50 ml/L., T₆ castor leaf extract 50 ml/L., T₇ cow dung ash 50kg/ha and T₈ untreated control in both years (2020-2021 and 2021-2022) *neem* leaf extract 5% (50ml/l) was found most effective followed by black pepper 5% (50ml/l), *datura* leaf extract 5% (50ml/l), eucalyptus leaf extract 5% (50ml/l), papaya leaf extract 5% (50ml/l), castor leaf extract 5% (50ml/l), cow dung ash (@ 50kg/ha) over untreated plot.

KEYWORDS: *Brassicacompestris* L., *Lipaphiserysimi* Kalt., botanicals.

I. INTRODUCTION

Mustard crops (*Brassica spp.*) are grown worldwide in both subtropical and temperate climates. In India, the *rabi* oilseed crop rapeseed-mustard is the most widely planted. In India, the use of '*Sarson*' is described in Ayurvedic Samhitas. '*Sorson*' seeds are antiseptic according to Sanskrit literature. Mustard seed is known by different names in different place e.g. '*sarson*', '*rai*', '*toria*' or '*lahi*'. '*Sarson*' and '*toria*' ('*lahi*') are generally termed as rapeseed, while '*rai*' or '*raya*' or '*laha*' is termed as mustard. More than 43 species of insect pests infest rapeseed-mustard crop in India, out of which about a dozen of species is considered as a major pest (Singh, 2009). The oil of mustard crop serves as very important cooking medium and dietary fat of the majority of the population in Northern, North-Western, Central, Eastern and North-Eastern State. It is also most common medium of pickling and food preserving. There different cultivated rapeseed and mustard species having different botanical name, which are collectively referred to as *Brassica spp.* There are several reasons for low and fluctuating productivity of mustard in the country. Among them, insect-pests are considered to be the major one because, insects attack on different parts of the plant and cause damage to the mustard crop, which result in a significant reduction in yield. *Brassica juncea* (L.) Czern&Coss (brown mustard), is an amphidiploid with a diploid chromosome number (2n) of 36. Mustard is a highly profitable crop for both domestic and foreign markets. It includes 38 to 46% edible oil, 38 to 57 per cent erucic acid, 4.7 to 13% linoleic acid, and 27% oleic acid, all of which are essential for human health. Mustard includes 37-49 per cent oil, 25-32 per cent proteins, 7% ash, 0.6 per cent calcium, 1.45 per cent phosphorus, 0.6 per cent magnesium, and 0.05 per cent manganese, as well as being a good source of vitamins. thiamine(mg/g) Niacin (mg/g) 5.2, riboflavin (mg/g) 160 Pantothenic acid, 3.7 folic acid, 9.5, Chlorine (mg/g): 2.3 6.7, as well as tocopherols cake weighs 1.5 t and includes 42 per cent crude proteins and 7% ash. (Damodaram and Hegde, 2010).

II. RELATED WORK

The infestation of mustard aphid occurs in the field from December to February. Both the adults and nymphs of this aphid cause damage to mustard plants from seedling to maturity, but maximum damage is caused at flowering stage (Ahmed and Jalil, 1993). The aphids suck sap from leaves, flower-buds, flowers, pod and twigs of the plants. They also secrete sticky honey dew which act as a medium for sooty mold development and reduce the photosynthetic efficiency of the plants. In case of severe infestation, leaves become curled, plant fails to develop pods, the young pods when developed fail to become mature and cannot produce healthy.

III. METHODOLOGY

The Botanicals were applied through foliar spray. The sprayings were done by using a pre-calibrated knapsack sprayer. The spray was given on first year (2020-2021) on 19 February 2021 and second year (2021-2022) on 15 February 2022 at the economic threshold level (ETL) 15-20 aphid per plant. The quantity of spray solution used was 600 liter per hectare in each spray. The solution was prepared according to the following formula.

Required quantity of insecticides was calculated using the formula as given below.

Required quantity of insecticide=

$$\frac{\text{Volume of spray fluid required } \left(\frac{\text{liter}}{\text{ha}} \right) \times \text{required concentration of insecticide } (\%)}{\text{Active ingredient in insecticide formulation } (\%)}$$

Evaluation of botanicals

The observations on aphid population were recorded from 10 randomly selected and tagged plants from each plot one day before and 3, 7 and 10 days after the application of botanicals sprays. The seed yield of mustard in each plot was computed and converted in to quintal per hectare basis. The data on aphid population was used for statistical analysis after transforming into $\sqrt{x + 0.5}$

$$\text{Pest intensity} = \frac{\text{Total no of nymphs and adults found on plants to be observed}}{\text{No of plants observed}}$$

$$\text{Pest infestation } (\%) = \frac{\text{No of plants infested}}{\text{Total no of randomly selected plants}} \times 100$$

The mean original data of population was calculated as percentage reduction over control with following formula (Abbot's formula, 1925)

$$A = \frac{C-T}{C} \times 100$$

Where,

A= reduction percentage in population over control.

C=percentage damage of control

T= percentage damage of treated plot

IV. EXPERIMENTAL RESULTS

Bio-efficacy of various Botanical insecticide against mustard aphid *Lipaphis erysimi* Kalt.

First spray during 2020-2021

Data presented in table no.1 showed that first day before of spray the aphid population ranges from 46.98 to 47.76 Aphids/10 cm central top twigs/ plant, hence the population was above the threshold level (ETL), so the botanical insecticide were applied at this time to minimized aphid population in an ecofriendly manner.

3 days after spray of botanical insecticide data presented in table no. 1 showed that *neem* leaf extract 5% (50ml/lt) was found with highest efficacy than other treatments with documentation of population 24.25 Aphids/10 cm top central twigs/plant and efficacy of this botanical insecticide in terms of reduction of mustard aphid population over control recorded 60.38 per cent followed by the efficacy of treatment T₄ Black pepper 5% (50ml/lt), treatment T₂ *Datura* leaf extract 5% (50ml/lt), treatment T₇ Eucalyptus leaf extract 5% (50ml/lt), treatment T₁ Papaya leaf extract 5% (50ml/lt), treatment T₆ Castor leaf extract 5% (50ml/lt) and treatment T₅ Cow dung ash (@50kg/ha) with recorded population such as 25.68, 27.10, 29.20, 30.21, 31.48 and 32.25 Aphids/10 cm top central twigs/plant, respectively, and efficacy of these botanicals insecticides in terms of per cent reduction of mustard aphid population over control documented such as 58.04, 55.72, 52.29, 50.64, 48.57, 47.31 per cent, respectively.

The effect of different treatments after 7 days of application of botanical insecticides on the population of mustard aphid showed in the table- 1 The aphid population of treatment T₃ documented superior 15.66 Aphids/10 cm top central twigs/plant than other treatments and efficacy of this botanical insecticide in terms of reduction of mustard aphid population over control recorded 77.23 per cent followed by the efficacy of treatment T₄ Black pepper 5% (50ml/lt), treatment T₂ *Datura* leaf extract 5% (50ml/lt), treatment T₇ Eucalyptus leaf extract 5% (50ml/lt), treatment T₁ Papaya leaf extract 5% (50ml/lt), treatment T₆ Castor leaf extract 5% (50ml/lt), treatment T₅ Cow dung ash with recorded population such as 16.98, 18.91, 19.10, 19.58, 20.24 and 21.78 Aphids/10 cm top central twigs/plant respectively and efficacy of these botanicals insecticides in terms of per cent reduction of mustard aphid population over control documented such as 75.31, 72.50, 72.23, 71.53, 70.57 and 68.33 per cent, respectively.

The treatment T₃ with botanical insecticide *neem* leaf extract were found highest efficacy in terms of mustard aphid *Lipaphiserysimi*Kalt. population management after 10 days of spray. The lowest population 4.10 recorded from treatment T₃. However, other treatments such as T₄ (Black pepper extract) 5% (50ml/lt), treatment T₂*Datura* leaf extract 5% (50ml/lt), treatment T₇ Eucalyptus leaf extract 5% (50ml/lt), treatment T₁ Papaya leaf extract 5% (50ml/lt), treatment T₆ Castor leaf extract 5% (50ml/lt), treatment T₅ Cow dung ash recorded higher population of mustard aphid than T₃ treatment such as 5.24, 7.20, 8.10, 9.25, 9.88 and 10.21 Aphids/10 cm top central twigs/plant respectively. The treatment T₃ *neem* leaf extract also recorded superior in terms of per cent reduction of mustard aphid *Lipaphiserysimi*Kalt. population 94.16 % over control. While, the remaining treatment like that treatment T₄ Black pepper 5% (50ml/lt), treatment T₂*Datura* leaf extract 5% (50ml/lt), treatment T₇ Eucalyptus leaf extract 5% (50ml/lt), treatment T₁ Papaya leaf extract 5% (50ml/lt), treatment T₆ Castor leaf extract 5% (50ml/lt) and treatment T₅ Cow dung ash recorded lowest efficacy in terms of per cent reduction of mustard aphid *Lipaphiserysimi*Kalt. population such as 92.53, 89.74, 88.46, 86.83, 85.93, 85.46 per cent, respectively.

So, that in above all botanical insecticides, highest efficacy of *neem* leaf extract reported after first spray over control than remaining botanical insecticides. However, other botanical insecticides were also deducted the aphid population satisfactorily over control.

Table 1 efficacy of botanicals against mustard aphid *lipaphiserysimi*kalt. After first spray during 2020-2021

*Figure of parentheses are $\sqrt{x + 0.5}$ transformed values, DBS = Days before spray, DAS = Days after spray

Treatments	Mean population of mustard aphid/10 cm central top twig/plant						
	1 DBS	3 DAS	% REDUCTION OVER CONTROL	7 DAS	% REDUCTION OVER CONTROL	10 DAS	% REDUCTION OVER CONTROL
Papaya leaf extract	47.76 (6.95)	30.21 (5.54)	50.64	19.58 (4.56)	71.53	9.25 (3.12)	86.83
Datura leaf extract	47.08 (6.90)	27.10 (5.25)	55.72	18.91 (4.40)	72.50	7.20 (2.77)	89.74
Neem leaf extract	46.98 (6.89)	24.25 (4.97)	60.38	15.66 (4.01)	77.23	4.10 (2.14)	94.16
Black Pepper	47.21 (6.91)	25.68 (5.11)	58.04	16.98 (4.18)	75.31	5.24 (2.39)	92.53
Cow dung ash	46.88 (6.88)	32.25 (5.72)	47.31	21.78 (4.72)	68.33	10.21 (3.27)	85.46
Castor leaf extract	47.10 (6.90)	31.48 (6.03)	48.57	20.24 (4.55)	70.57	9.88 (3.22)	85.93
Eucalyptus leaf extract	46.48 (6.85)	29.20 (5.44)	52.29	19.10 (4.42)	72.23	8.10 (2.93)	88.46
Control	47.21 (6.91)	61.21 (7.85)	0	68.78 (8.32)	0	70.24 (8.41)	0
SE±	0.192	0.109		.082		0.079	
CD @ 5%	NS	0.332		0.247		0.241	

Second spray during 2020-2021

The mustard aphid population recorded one day prior to spray founded between 33.98 to 73.68 aphids/10 cm top central twigs/plant. So, this range of population goes beyond ETL, for their management applied botanical insecticides as foliar spray in different treatments at different days interval.

The data after 3 days of application of botanical insecticides presented in Table-2 showed that the treatment T₃ of botanical insecticide *neem* leaf extract recorded highest efficacy in terms of mustard aphid population 24.28 aphids/10 cm top central twigs/plant management compare to other treatment followed by treatment T₄ Black pepper 5% (50ml/lit), treatment T₂ *Datura* leaf extract 5% (50ml/lit), treatment T₇ Eucalyptus leaf extract 5% (50ml/lit), treatment T₁ Papaya leaf extract 5% (50ml/lit), treatment T₆ Castor leaf extract 5% (50ml/lit), treatment T₅ Cow dung ash (@50kg/ha) with recorded mustard aphid population as 25.62, 26.78, 26.98, 28.10, 28.35 and 28.98 aphids/10 cm top central twigs/plant. The efficacy of treatment T₃ of botanical insecticide *neem* leaf extract recorded highest efficacy in terms of per cent reduction of aphid population 68.57% over control followed by the treatment T₄ Black pepper 5% (50ml/lit), treatment T₂ *Datura* leaf extract 5% (50ml/lit), treatment T₇ Eucalyptus leaf extract 5% (50ml/lit), treatment T₁ Papaya leaf extract 5% (50ml/lit), treatment T₆ Castor leaf extract 5% (50ml/lit), treatment T₅ Cow dung ash (@50kg/ha) recorded effective for per cent reduction of aphid population such as 66.83, 65.33, 65.07, 63.62, 63.30, 62.49 per cent, respectively after 3 days spraying, all treatment were found superior over control.

The data after 7 days of application of botanical insecticides presented in Table-2 The treatment T₃ of botanical insecticide *neem* leaf extract recorded highest efficacy in terms of mustard aphid population 17.09 aphids/10 cm top central twigs/plant management compare to other treatment followed by treatment T₄ Black pepper 5% (50ml/lit), treatment T₂ *Datura* leaf extract 5% (50ml/lit), treatment T₇ Eucalyptus leaf extract 5% (50ml/lit), treatment T₁ Papaya leaf extract 5% (50ml/lit), treatment T₆ Castor leaf extract 5% (50ml/lit), treatment T₅ Cow dung ash with recorded mustard aphid population as 19.08, 20.02, 20.88, 21.45, 22.10, and 23.75 aphids/10 cm top central twigs/plant. The efficacy of treatment T₃ of botanical insecticide *neem* leaf extract also recorded highest efficacy in terms of per cent reduction of aphid population 79.09% over control followed by the treatment T₄ Black pepper 5% (50ml/lit), treatment T₂ *Datura* leaf extract 5% (50ml/lit), treatment T₇ Eucalyptus leaf extract 5% (50ml/lit), treatment T₁ Papaya leaf extract 5% (50ml/lit), treatment T₆ Castor leaf extract 5% (50ml/lit), treatment T₅ Cow dung ash recorded effective for per cent reduction of aphid population such as 76.65, 75.18, 74.45, 73.75, 72.96, 70.94 per cent, respectively after 7 days of spraying & here also all treatments were found significant by superior over control.

The treatment T₃ with botanical insecticide *neem* leaf extract were found highest efficacy in terms of mustard aphid *Lipaphis erysimi* Kalt. population management after 10 days of spray. The lowest population 6.10 recorded from treatment T₃. However, other treatments such as T₄ Black pepper 5% (50ml/lit), treatment T₂ *Datura* leaf extract 5% (50ml/lit), treatment T₇ Eucalyptus leaf extract 5% (50ml/lit), treatment T₁ Papaya leaf extract 5% (50ml/lit), treatment T₆ Castor leaf extract 5% (50ml/lit), treatment T₅ Cow dung ash (@50kg/ha) recorded higher population of mustard aphid than T₃ treatment such as 6.80, 7.10, 7.50, 9.24, 10.78, and 11.25 Aphids/10 cm top central twigs/plant respectively.

Table: 2 Efficacy of botanicals against mustard aphid *Lipaphis erysimi* Kalt. after second spray during 2020-2021

Treatments	Mean population of mustard aphid/10 cm central top twig/plant						
	1 DBS	3 DAS	% Reduction Over Control	7 DAS	% Reduction Over Control	10 DAS	% Reduction Over Control
Papaya leaf extract	34.68 (5.93)	28.10 (5.35)	63.62	21.45 (4.69)	73.75	9.24 (3.12)	89.28
Datura leaf extract	35.20 (5.97)	26.78 (5.22)	65.33	20.28 (4.56)	75.18	7.10 (2.76)	91.76
Neem leaf extract	34.98 (5.95)	24.28 (4.97)	68.57	17.09 (4.19)	79.09	6.10 (2.57)	92.92
Black Pepper	35.24 (5.97)	25.62 (5.11)	66.83	19.08 (4.42)	76.65	6.80 (2.70)	92.11
Cow dung ash	36.10 (6.04)	28.98 (5.33)	62.49	23.75 (4.92)	70.94	11.25 (3.43)	86.95
Castor leaf extract	34.88 (5.94)	28.35 (5.37)	63.30	22.10 (4.75)	72.96	10.78 (3.36)	87.49
Eucalyptus leaf extract	33.98 (5.87)	26.98 (5.24)	65.07	20.88 (4.62)	74.45	7.50 (2.83)	91.30
Control	73.68 (8.61)	77.25 (8.81)	0.00	81.72 (9.07)	0.00	86.20 (9.31)	0.00
SE±	0.101	0.070		0.147		0.177	

*Figure of parentheses are $\sqrt{x + 0.5}$ transformed values, DBS = Days before spray, DAS = Days after spray

The treatment T₃ *neem* leaf extract also recorded superior in terms of per cent reduction of mustard aphid *Lipaphiserysimi*Kalt. population 92.92 per cent over control. While, the remaining treatment like that treatment T₄ Black pepper 5% (50ml/lt), treatment T₂*Datura* leaf extract 5% (50ml/lt), treatment T₇ Eucalyptus leaf extract 5% (50ml/lt), treatment T₁ Papaya leaf extract 5% (50ml/lt), treatment T₆ Castor leaf extract 5% (50ml/lt) and treatment T₅ Cow dung ash @50kg/ha. recorded lowest efficacy in terms of per cent reduction of mustard aphid *Lipaphiserysimi*Kalt. population such as 92.11, 91.76, 91.30, 89.28, 87.49, 86.95 per cent, respectively.

In second spray results recorded that the treatment T₃ with botanical insecticide *neem* leaf extract found most lethal against mustard aphid *Lipaphiserysimi*Kalt. and all treatments also recorded most effective over control.

First spray during 2021-2022

Data presented in table no.3 showed that first day before of spray the aphid population ranges from 46.02 to 48.42 Aphids/10 cm central top twigs/ plant, hence the population was above the threshold level (ETL), so the botanical insecticide were applied at this time to minimized aphid population in an ecofriendly manner.

3 days after spray of botanical insecticide data presented in table no. 3 showed that *neem* leaf extract 5% (50ml/lt) was found with highest efficacy than other treatments with documentation of population 25.02 Aphids/10 cm top central twigs/plant and efficacy of this botanical insecticide in terms of reduction of mustard aphid population over control recorded 58.97 per cent followed by the efficacy of treatment T₄ Black pepper 5% (50ml/lt), treatment T₂*Datura* leaf extract 5% (50ml/lt), treatment T₇ Eucalyptus leaf extract 5% (50ml/lt), treatment T₁ Papaya leaf extract 5% (50ml/lt), treatment T₆ Castor leaf extract 5% (50ml/lt) and treatment T₅ Cow dung ash (@50kg/ha) with recorded population such as 25.98, 26.88, 28.92, 30.18, 31.98 and 32.21 Aphids/10 cm top central twigs/plant, respectively, and efficacy of these botanicals insecticides in terms of per cent reduction of mustard aphid population over control documented such as 57.39, 55.91, 52.57, 50.50, 47.55 and 47.19 per cent, respectively.

The effect of different treatments after 7 days of application of botanical insecticides on the population of mustard aphid showed in the table- 3 The aphid population of treatment T₃ documented superior 14.40 Aphids/10 cm top central twigs/plant than other treatments and efficacy of this botanical insecticide in terms of reduction of mustard aphid population over control recorded 78.44 per cent followed by the efficacy of treatment T₄ Black pepper 5% (50ml/lt), treatment T₂*Datura* leaf extract 5% (50ml/lt), treatment T₇ Eucalyptus leaf extract 5% (50ml/lt), treatment T₁ Papaya leaf extract 5% (50ml/lt), treatment T₆ Castor leaf extract 5% (50ml/lt), treatment T₅ Cow dung ash with recorded population such as 17.11, 18.92, 19.02, 19.24, 20.12 and 20.82 Aphids/10 cm top central twigs/plant respectively and efficacy of these botanicals insecticides in terms of per cent reduction of mustard aphid population over control documented such as 74.44, 71.68, 71.53, 71.20, 69.88 and 68.44 per cent, respectively.

Table 3 Efficacy of botanicals against mustard aphid *Lipaphiserysimi*Kalt. after first spray during 2021-2022

Treatments	Mean population of mustard aphid/10 cm central top twig/plant						
	1 DBS	3 DAS	% REDUCTION OVER CONTROL	7 DAS	% REDUCTION OVER CONTROL	10 DAS	% REDUCTION OVER CONTROL
Papaya leaf extract	46.84 (6.88)	30.18 (5.54)	50.50	19.24 (4.44)	71.20	9.11 (3.10)	87.00
Datura leaf extract	47.81 (6.95)	26.88 (5.23)	55.91	18.92 (4.41)	71.68	7.01 (2.74)	90.00
Neem leaf extract	48.42 (6.99)	25.02 (5.05)	58.97	14.40 (3.86)	78.44	3.92 (2.10)	94.40
Black Pepper	46.02 (6.82)	25.98 (5.15)	57.39	17.11 (4.20)	74.39	5.20 (2.39)	92.58
Cow dung ash	46.78 (6.88)	32.21 (5.72)	47.19	20.82 (4.62)	68.84	10.12 (3.26)	85.56
Castor leaf extract	47.01 (6.89)	31.98 (5.70)	47.55	20.12 (4.54)	69.88	9.78 (3.21)	86.04
Eucalyptus leaf extract	46.21 (6.83)	28.92 (5.42)	52.57	19.02 (4.42)	71.53	7.91 (2.90)	88.71
Control	47.45 (6.83)	60.98 (7.84)	00.00	66.82 (8.20)	00.00	70.10 (8.40)	00.00
SE±	0.072	0.049		0.089		0.085	

The treatment T_3 with botanical insecticide *neem* leaf extract were found highest efficacy in terms of mustard aphid *Lipaphiserysimi*Kalt. population management after 10 days of spray. The lowest population 3.92 recorded from treatment T_3 . However, other treatments such as T_4 (Black pepper extract) 5% (50ml/lt), treatment T_2 *Datura* leaf extract 5% (50ml/lt), treatment T_7 Eucalyptus leaf extract 5% (50ml/lt), treatment T_1 Papaya leaf extract 5% (50ml/lt), treatment T_6 Castor leaf extract 5% (50ml/lt), treatment T_5 Cow dung ash recorded higher population of mustard aphid than T_3 treatment such as 5.20, 7.01, 7.91, 9.11, 9.78 and 10.12 Aphids/10 cm top central twigs/plant respectively. The treatment T_3 *neem* leaf extract also recorded superior in terms of per cent reduction of mustard aphid *Lipaphiserysimi*Kalt. population 94.40 % over control. While, the remaining treatment like that treatment T_4 Black pepper 5% (50ml/lt), treatment T_2 *Datura* leaf extract 5% (50ml/lt), treatment T_7 Eucalyptus leaf extract 5% (50ml/lt), treatment T_1 Papaya leaf extract 5% (50ml/lt), treatment T_6 Castor leaf extract 5% (50ml/lt) and treatment T_5 Cow dung ash recorded lowest efficacy in terms of per cent reduction of mustard aphid *Lipaphiserysimi*Kalt. population such as 92.58, 90.00, 88.71, 87.00, 86.04, 85.56 per cent, respectively. So, that in above all botanical insecticide highest efficacy of treatment T_3 *neem* leaf extract reported after first spray over control than remaining botanical insecticide. However, other botanical insecticide also deducted the aphid population satisfactorily over control treatment.

Second spray during 2021-2022

The mustard aphid population recorded one day prior to spray founded between 34.10 to 72.98 aphids/10 cm top central twigs/plant. So, this range of population goes beyond ETL, for their management applied botanical insecticides as foliar spray in different treatments at different days interval.

The data after 3 days of application of botanical insecticides presented in Table-4 showed that the treatment T_3 of botanical insecticide *neem* leaf extract recorded highest efficacy in terms of mustard aphid population 24.34 aphids/10 cm top central twigs/plant management compare to other treatment followed by treatment T_4 Black pepper 5% (50ml/lt), treatment T_2 *Datura* leaf extract 5% (50ml/lt), treatment T_7 Eucalyptus leaf extract 5% (50ml/lt), treatment T_1 Papaya leaf extract 5% (50ml/lt), treatment T_6 Castor leaf extract 5% (50ml/lt), treatment T_5 Cow dung ash (@50kg/ha) with recorded mustard aphid population as 26.96, 27.11, 27.98, 28.96, 29.11 and 29.24 aphids/10 cm top central twigs/plant. The efficacy of treatment T_3 of botanical insecticide *neem* leaf extract recorded highest efficacy in terms of per cent reduction of aphid population 68.07% over control followed by the treatment T_4 Black pepper 5% (50ml/lt), treatment T_2 *Datura* leaf extract 5% (50ml/lt), treatment T_7 Eucalyptus leaf extract 5% (50ml/lt), treatment T_1 Papaya leaf extract 5% (50ml/lt), treatment T_6 Castor leaf extract 5% (50ml/lt), treatment T_5 Cow dung ash (@50kg/ha) recorded effective for per cent reduction of aphid population such as 64.63, 64.57, 63.30, 62.01, 61.81, 61.64 per cent, respectively after 3 days of spraying & here also all treatments were found significant by superior over control.

Table: 4 Efficacy of botanicals against mustard aphid *Lipaphiserysimi*Kalt. after second spray during 2021-2022

Treatments	Mean population of mustard aphid/10 cm central top twig/plant						
	1 DBS	3 DAS	% Reduction Over Control	7 DAS	% Reduction Over Control	10 DAS	% Reduction Over Control
Papaya leaf extract	35.21 (5.98)	28.96 (5.43)	62.01	22.10 (4.75)	72.52	9.18 (3.11)	89.46
Datura leaf extract	34.90 (5.95)	27.98 (5.34)	63.30	21.50 (4.69)	73.27	7.88 (2.89)	90.95
Neem leaf extract	34.10 (5.83)	24.34 (4.98)	68.07	13.28 (3.71)	83.49	3.88 (2.09)	95.54
Black Pepper	35.24 (5.98)	26.96 (5.24)	64.63	18.24 (4.33)	77.32	4.82 (2.30)	94.46
Cow dung ash	36.12 (6.05)	29.24 (5.45)	61.64	23.84 (4.93)	70.36	11.34 (3.44)	86.98
Castor leaf extract	35.45 (6.00)	29.11 (5.44)	61.81	23.01 (4.85)	71.39	10.91 (3.38)	87.47
Eucalyptus leaf extract	34.82 (5.94)	27.11 (5.25)	64.57	21.12 (4.65)	73.74	7.42 (2.81)	91.48
Control	72.98 (8.57)	76.24 (8.76)	00.00	80.45 (9.00)	00.00	87.10 (9.36)	00.00
SE \pm	0.057	0.057		0.074		0.068	

The data after 7 days of application of botanical insecticides presented in Table-4 The treatment T₃ of botanical insecticide *neem* leaf extract recorded highest efficacy in terms of mustard aphid population 13.28 aphids/10 cm top central twigs/plant management compare to other treatment followed by treatment T₄ Black pepper 5% (50ml/lit), treatment T₂ *Datura* leaf extract 5% (50ml/lit), treatment T₇ Eucalyptus leaf extract 5% (50ml/lit), treatment T₁ Papaya leaf extract 5% (50ml/lit), treatment T₆ Castor leaf extract 5% (50ml/lit), treatment T₅ Cow dung ash with recorded mustard aphid population as 18.24, 21.12, 21.50, 22.10, 23.01 and 23.84 aphids/10 cm top central twigs/plant. The efficacy of treatment T₃ of botanical insecticide *neem* leaf extract also recorded highest efficacy in terms of per cent reduction of aphid population 83.49 % over control followed by the treatment T₄ Black pepper 5% (50ml/lit), treatment T₂ *Datura* leaf extract 5% (50ml/lit), treatment T₇ Eucalyptus leaf extract 5% (50ml/lit), treatment T₁ Papaya leaf extract 5% (50ml/lit), treatment T₆ Castor leaf extract 5% (50ml/lit), treatment T₅ Cow dung ash recorded effective for per cent reduction of aphid population such as 77.32, 73.74, 73.27, 72.52, 71.39, 70.36 per cent, respectively after 7 days of spraying & here also all treatments were found significant by superior over control.

The treatment T₃ with botanical insecticide *neem* leaf extract were found highest efficacy in terms of mustard aphid *Lipaphis erysimi* Kalt. population management after 10 days of spray. The lowest population 3.88 recorded from treatment T₃. However, other treatments such as T₄ Black pepper 5% (50ml/lit), treatment T₂ *Datura* leaf extract 5% (50ml/lit), treatment T₇ Eucalyptus leaf extract 5% (50ml/lit), treatment T₁ Papaya leaf extract 5% (50ml/lit), treatment T₆ Castor leaf extract 5% (50ml/lit), treatment T₅ Cow dung ash (@50kg/ha) recorded higher population of mustard aphid than T₃ treatment such as 4.82, 7.42, 7.88, 9.18, 10.91 and 11.34 Aphids/10 cm top central twigs/plant respectively. The treatment T₃ *neem* leaf extract also recorded superior in terms of per cent reduction of mustard aphid *Lipaphis erysimi* Kalt. population 95.54 per cent over control. While, the remaining treatment like that treatment T₄ Black pepper 5% (50ml/lit), treatment T₂ *Datura* leaf extract 5% (50ml/lit), treatment T₇ Eucalyptus leaf extract 5% (50ml/lit), treatment T₁ Papaya leaf extract 5% (50ml/lit), treatment T₆ Castor leaf extract 5% (50ml/lit) and treatment T₅ Cow dung ash @50kg/ha. recorded lowest efficacy in terms of per cent reduction of mustard aphid *Lipaphis erysimi* Kalt. population such as 94.46, 91.48, 90.95, 89.46, 87.47, 86.98 per cent, respectively. In second spray results recorded that the treatment T₃ with botanical insecticide *neem* leaf extract found most lethal against mustard aphid *Lipaphis erysimi* Kalt. and all treatments were also recorded most effective as compared to control.

These findings are being supported by Biswas (2013) recorded that the *neem* leaf extracts reduced 63.16-72.55% aphid population in mustard while *neem* seed extract reduced 73-81% aphid population over pretreated plants in both the years. Among the different doses of *neem* extracts, the highest aphid population reduction over pretreatment (81%) was recorded from 50g *neem* seed per liter of water treated plots with high MBCR (3.88) followed by 75g *neem* seed/l treated plots having reduction of 80% and MBCR (3.78). Gupta et al. (2001) evaluated the botanical based (*neem*) insecticide against mustard aphid in seven types of *neem* based products they were found considerable responses against aphid, highest efficacy got among *neem* gold spray with *neemazal* highest aphid population reduction and *neemarin* among lowest and spray with *neemgold*.

V. CONCLUSION

Results of current investigation showed that the effectiveness of botanical insecticide (*neem* Leaf Extract 5% @ 50ml/lit) against mustard aphid was found most effective followed by botanical insecticide Black Pepper Extract 5% @ 50ml/lit. treatment T₂ *Datura* leaf extract 5% (50ml/lit), treatment T₇ Eucalyptus leaf extract 5% (50ml/lit), treatment T₁ Papaya leaf extract 5% (50ml/lit), treatment T₆ Castor leaf extract 5% (50ml/lit) and treatment T₅ Cow dung ash @50kg/ha. This experimental conclusion mainly based on two-year investigation. The effectiveness of botanical insecticide on management approach against mustard aphid, found that the use of botanical based insecticide mainly responsible for reduction of yield losses of the crop as well as providing protection against ill effects on human health and environment.

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