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EFFICACY OF SOME PHYTO EXTRACTS AND INSECTICIDES FOR THE MANAGEMENT OF APHID [*LIPAPHIS ERYSIMI* (KALTENBACH)] IN MUSTARD

PRADIP KUMAR PATEL, SAMEER KUMAR SINGH*, KAMAL RAVI SHARMA, UMESH CHANDRA AND VIJAY KUMAR MISHRA[1]

Department of Entomology, College of Agriculture, Acharya Narendra Deva University of Agriculture and Technology, Kumarganj, Ayodhya - 224 229, Uttar Pradesh, India

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Abstract

In the assessment of treatments for management of mustard aphid, it was observed that Neemazal T/S 10,000 ppm (T_4) application was the most effective among phyto extracts resulting in the lowest aphid population (15.26 and 7.48 mustard aphid/10cm central twig in first and second spray population, respectively) and yielding the highest output of 12.71 q/ha following closely to T_3, which yielded 11.94 q/ha. The treatment T_4 also generated the highest net return (Rs. 23927.33/ha) and cost-benefit ratio (1:9.97), trailed by T_3 (Rs.20233.58/ha and 1:9.28). Other treatments ranked in terms of effectiveness include, Dashparni ark @ 3% (T_1), *Lantana camera* leaf extract @ 5% (T_6), Mixed leaf extract @ 3% (T_2), Garlic extract @ 5% (T_8), and *Parthenium* leaf extract @ 5% (T_5). Treatment T_7 was found the least effective among those tested. As for the standard check, Imidacloprid 17.8 SL @ 0.05% (T_9) exhibited the most significant impact with a yield of 13.87 q/ha, net return of ₹29851.67/ha and a cost-benefit ratio of 1:12.98.

Introduction

Mustard is a significant oilseed crop after palm oil and soybean oil; mustard seed is the third largest source of vegetable oil in the world. Rapeseed mustard has oil content that ranges from 33 per cent, while the typical oil recovery is between 32 to 38 per cent (Dwivedi *et al.* 2019).

Approximately fifty species of insect pests have been found to infesting *Brassica* crop in India, out of this about fifteen species are the serious threat and cause serious damage to mustard and considered as major pests namely, mustard saw fly (*Athalia lugens proxima* Klug.), mustard aphid (*Lipaphis erysimi* Kalt.), painted bug (*Bagrada cruciferum* Kirk), peach aphid (*Myzus persicae* Sulzer), cabbage butterfly (*Pieris brassicae* Linn.), cabbage aphid (*Brevicoryne brassicae* Linn.), diamond back moth (*Plutela xylostella* Linn.), cut worm (*Agrotis segatum* Dennis & Schiff) and stem fly (*Melanagromyza cleome* Spencer) (Bakhetia and Sekhon 1989, Sharma and Singh 2010). Among them, mustard aphid (*L. erysimi* Kalt.) is one of the most destructive, which is responsible for causing severe reduction in seed yield varying from 15.00 to 96.00 per cent (Kolte 2009, Sharma and Singh 2010, Sahoo 2012) and can reduce 5-6 per cent oil content (Patel *et al.* 2004, Karmakar 2003, Shylesha *et al.* 2006).

A good number of chemical insecticides were found effective against mustard aphid in diverse parts of the country (Singh *et al.* 2013). But chemical insecticides are not only toxic to mustard aphid as well as to natural enemies (Nagar *et al.* 2012), but these are also accountable for health hazards to human beings, environmental pollution, pest resurgence, toxic to pollinators, development pest resistance and residues (Singh 2001). Plant extracts and organic based insecticides, on the other hand, are comparatively less toxic to the non-target organisms, easily

*Author for correspondence: <drsameerent@nduat.org>. [1]Department of Entomology, College of Agriculture, Chaudhary Charan Singh Haryana Agricultural University, Hisar-125004, India.

degradable and least toxic to the environment (Pickett and Bugg 1998, Ruberson *et al*. 1998, Srivastava and Guleria 2003, Isman 2006). Many plants are being used traditionally for controlling pest since long before. There are many plant extracts that have been proven as successful management option for many pests in the field and laboratory experiments (Bajpai and Sehgal 2000, Jahan *et al*. 2013, Rahman *et al*. 2016, Sultana *et al*. 2017). Hence, it is essential to find out the most effective plant extract for managing mustard aphid to defend the natural enemies and pollinators as well as human health.

Materials and Methods

The experiments were carried out by growing a popular variety, Narendra Rai (NDR-8501) in 2020-21 and 2021-22 at Students' Instructional Farm, Acharya Narendra Deva University of Agriculture and Technology, Kumarganj, Ayodhya, Uttar Pradesh, India. The experiment was planned in Randomized Block Design (RBD) with three replications and ten treatments. The plot size was 4 m × 3 m with spacing of 45cm and 15 cm from row to row and plant to plant, respectively. The recommended agronomic practices were followed to raise the crop. The treatments comprised Dashparni Ark 3% (T_1) (To prepare Dashparni Ark, crushed 5 kg neem leaves, 2 kg Vitex negundo leaves, 2 kg Aristolochia leaves, 2 kg papaya, 2 kg *Tinospora cordifolia* leaves, 2 kg *Annona squamosa* leaves, 2 kg *Pongamia pinnata* leaves, 2 kg *Ricinus communis* leaves, 2 kg *Nerium indicum* leaves, 2 kg *Calotropis procera* leaves, 2 kg green chilli paste, 250g garlic paste, 3 kg cow dung and 5 litres of cow urine were mixed in 200 litres of water. Fermented for one month and shaken regularly three times a day, then filtered and squeezed the extract). Mixed extract 3% (T_2) (To make mixed leaf extract, crushed 3 kg neem leaves in 10 litres of cow urine and crushed 2 kg custard apple leaves, 2 kg papaya leaves, 2 kg pomegranate leaves and 2 kg guava leaves in water. Mixed the two and boiled five times at intervals until the volume reduced to half. Kept for 24 hrs, then filtered and squeezed the extract). NSKE 5% (T_3), Parthenium Leaf extract 5% (T_5), *Lantana camara* Leaf extract 5% (T_6), and Chenopodium Leaf extract 5% (T_7) (for the preparation of these phytoextracts, seed kernels or leaves were collected, cleaned, sun-dried, and kept in the lab. A mortar was used to grind dried neem seeds or leaves into a powder. 500 ml of water was used to soak 250 g of seed or leaf powder for 24 hrs in order to make a 50% solution. After 30 minutes of centrifuging at 4000 rpm, it was filtered using muslin cloth. Water was added to the filter to make it 500 ml in volume, which was then stored as a stock solution for field spraying). Neemazal T/S 0.03% (T_4) (an Azadirachtin-based botanical pesticide which contains Azadirachtin 10,000 ppm), Garlic extract 5% (T_8) (The garlic was collected and crushed with the help of a pestle. To prepare 50 per cent garlic extract, 250 g garlic paste was soaked in 500 ml of water for 24 hrs. Thereafter, it was centrifuged at 4000 rpm for 30 min and filtered with the help of muslin cloth. The volume of the filtrate was made 500 ml by adding water and kept as a stock solution for use under field conditions), Imidacloprid 17.8 SL (Standard check) 0.05% (T_9) and Control (Water Spray) (T_{10}).

The crop was regularly monitored to record the incidence of aphid up to Economic Threshold Level (ETL-50-60 aphids/10cm central twig/plant). Treatments were applied, when mustard aphid population reached at ETL. The population of aphid was recorded on ten randomly selected plants from each plot at one day before and 3, 7 and 10 days after spray (DAS) in each plot. The mustard crop was harvest at maturity. The yield was also being recorded from each plot separately to determine the effects of treatment on yield. The economics of different treatments were worked out following formula used in Ojha *et al.* (2017). The data were subordinate to statistical analysis after tabulation into transformation values. The population data were transformed to $\sqrt{x + 0.5}$. The data obtained were analyzed statistically to compare the treatment effects (Panse and Sukhatme 1961).

Results and Discussion

The data pertaining efficacy of the first spray indicates that aphid population one day before spray was ranged 80.92 to 89.27 aphids (Table 1). The results of the experiments showed that all treatments were significantly superior over control, when observations were on 3 days after spray. The treatment T_4 showed significantly lower number of mustard aphids with mean population of 20.31 aphids and gave more protection to rapeseed mustard followed by T_3 (21.96 aphids). The plots treated with *Chenopodium* leaf extract @ 5% at T_7 (34.27 aphids) was least effective treatment among all tested options.

The observation recorded 7 DAS indicates that all the treatments were also significantly superior over control. Again, the treatment T_4 showed significantly lower number of mustard aphid with mean population of 10.25 aphids followed by T_3 (12.25 aphids) and T_7 was found to be the least effective. However, in the T_9 there was 4.67 aphids and found more effective over all the treatments and in control (Water spray) had the highest mean population 84.42 aphids/10cm central twig/plant was obtained among all.

At 10 DAS data revealed that all the treatments were found significantly superior over control. The treatment T_4 showed significantly lower number of mustard aphids with mean population of 15.22 aphids and provided more protection to rapeseed mustard. The next treatment in order of superiority was T_3 (18.57 aphids). The treatment T_7 depicted the highest number of aphid population and proved to be least effective treatment. However, the population in T_9 was 9.27 aphids. The highest population was found in treatment control (Water spray) with the mean population of 94.77 aphids.

The pooled mean population of 3, 7 and 10 DAS depicted that all the treatments were also found significantly superior over control. The treatment T_4 showed significantly lower number of mustard aphid (15.26 aphids) followed by T_3. The plot treated with *Chenopodium* leaf extract @ 5% at T_7 was found least effective with highest number of aphids. However, the population in T_9 (Standard check) was 9.31 aphids. The highest population was found in control (water spray) with mean population of 87.17 aphids.

The data pertaining second spray population a day before spray was varied from 52.86 to 80.81 aphids (Table 1). All the treatments were significantly superior over control, when observations were made on 3 days after spray. The treatment T_4 showed significantly lower number of mustard aphids with mean population of 8.12 aphids which was followed by T_3 and T_7. The next treatment to superiority was T_3 and then T_7. However, the population in T_9 (standard check) was 2.70 aphids and found more effective over all the treatments. The highest population was found in control (water spray) with the mean population 73.55 aphids.

At 7 days after spray all the treatments were found significantly superior over control. The treatment T_4 showed significantly lower number of mustard aphids with mean population of 4.72 aphids and gave more protection followed by T_3. The least effective treatment was T_7. However, the population in T_9 (standard check) was 1.05 aphids and found more effective over all the treatments. The highest population was found in control (water spray) with the mean population of 76.97 aphids.

At 10 DAS, all the treatments were found significantly superior over control. Again, T_4 was found the best treatment and showed significantly lower number of mustard aphid population, which provided more protection to rapeseed mustard which is followed by T_3 and the treatment which showed least effectiveness was T_7. The control (Water spray) recorded the highest mean population 75.46 aphid. The standard check at T_9 was most effective among all the treatments with aphid population (4.67 aphids).

Table 1. Efficacy of some phyto extracts and insecticides against mustard aphid during *Rabi* 2020-21 & 2021-22.

Treatments	Dose (%)	Mean mustard aphid population/10 cm central twig									Yield (q/ha)
		DBS	DAS (First)				DBS	DAS (Second)			
			3	7	10	Mean		3	7	10	Mean	
T_1	3	80.92	24.35	14.58	19.77	19.57	52.86	10.35	8.48	11.23	10.02	11.37
		(9.00)	(4.94)	(3.83)	(4.45)	(4.48)	(7.27)	(3.22)	(2.92)	(3.36)	(3.24)	
T_2	3	81.65	30.42	20.45	26.97	25.95	52.38	12.52	10.05	13.03	11.87	9.52
		(9.04)	(5.52)	(4.53)	(5.20)	(5.14)	(7.24)	(3.54)	(3.18)	(3.62)	(3.52)	
T_3	5	82.14	21.96	12.25	18.57	17.59	52.56	9.63	5.12	10.62	8.46	11.94
		(9.07)	(4.69)	(3.51)	(4.31)	(4.25)	(7.25)	(3.11)	(2.27)	(3.27)	(2.99)	
T_4	0.03	81.54	20.31	10.25	15.22	15.26	55.99	8.12	4.72	9.62	7.48	12.71
		(9.03)	(4.51)	(3.21)	(3.91)	(3.97)	(7.49)	(2.86)	(2.18)	(3.11)	(2.83)	
T_5	5	83.55	31.52	22.45	29.37	27.78	58.02	12.83	11.07	14.00	12.63	9.08
		(9.14)	(5.62)	(4.74)	(5.42)	(5.32)	(7.62)	(3.59)	(3.33)	(3.75)	(3.62)	
T_6	5	86.28	28.19	18.02	23.43	23.21	58.68	11.28	9.03	11.63	10.65	10.61
		(9.29)	(5.31)	(4.25)	(4.85)	(4.87)	(7.66)	(3.37)	(3.01)	(3.42)	(3.34)	
T_7	5	85.28	34.27	27.42	31.15	30.94	62.38	13.68	12.17	15.07	13.64	8.46
		(9.24)	(5.86)	(5.24)	(5.59)	(5.61)	(7.90)	(3.71)	(3.50)	(3.89)	(3.76)	
T_8	5	84.46	29.07	19.42	25.32	24.60	64.84	11.20	9.67	12.37	11.08	9.88
		(9.19)	(5.40)	(4.41)	(5.04)	(5.01)	(8.06)	(3.35)	(3.12)	(3.52)	(3.40)	
T_9	0.05	82.73	14.01	4.67	9.27	9.31	54.28	2.70	1.05	4.67	2.81	13.87
		(9.10)	(3.75)	(2.17)	(3.05)	(3.13)	(7.37)	(1.66)	(1.05)	(2.17)	(1.82)	
T_{10}	-	89.27	82.33	84.42	94.77	87.17	80.81	73.55	76.97	75.46	75.33	7.50
		(9.45)	(9.08)	(9.19)	(9.74)	(9.36)	(8.99)	(8.58)	(8.78)	(8.69)	(8.71)	
CD at 5%		NS	(0.15)	(0.27)	(0.17)	(0.42)	(0.53)	(0.13)	(0.10)	(0.12)	(0.32)	1.12
Sem±		-	(0.05)	(0.09)	(0.06)	(0.14)	(0.18)	(0.04)	(0.03)	(0.04)	(0.11)	0.38

Figures in parentheses are transformed values, DBS: Days Before Spray, DAS: Days After Spray, NS: Non-Significant.

Table 2. Economics of some phyto extracts and insecticides in yield of rapeseed mustard during *Rabi* 2020-21 & 2021-22.

Treatment No.	Dose (%)	Quantity of Chemical Kg or L/ha	Cost of one spray (labour + sprayer + insecticides) (Rs/ha)	No. of sprays	Total cost of treatments (Rs/ha)	Grain yield (q/ha)	Saved yield (q/ha)	Value of saved yield (Rs/ha)	Net returns	Incremental benefit cost ratio (B:C)
T_1	3	18.00	1060.00	2	2120.00	11.37	3.87	19543.50	17423.50	8.21:1
T_2	3	18.00	800.00	2	1600.00	9.52	2.02	10184.17	8584.17	5.36:1
T_3	5	30.00	1090.00	2	2180.00	11.94	4.44	22413.58	20233.58	9.28:1
T_4	0.03	00.18	1200.00	2	2400.00	12.71	5.21	26327.33	23927.33	9.97:1
T_5	5	30.00	800.00	2	1600.00	9.08	1.58	7995.83	6395.83	3.99:1
T_6	5	30.00	800.00	2	1600.00	10.61	3.11	15713.92	14113.92	8.82:1
T_7	5	30.00	800.00	2	1600.00	8.46	0.96	4839.58	3239.58	2.02:1
T_8	5	30.00	2450.00	2	4900.00	9.88	2.38	12035.83	7135.83	1.45:1
T_9	0.05	00.30	1150.00	2	2300.00	13.87	6.37	32151.67	29851.67	12.98:1
T_{10}	3	-	-	2	-	7.50	-	-		-

Rent of sprayer @ Rs. 100/day: Rs.200/-, Labour charge @ Rs. 250/day: Rs. 500/-, Cost of produce Rs. 5050/q.

When the observations were made on overall mean days after spray all the treatments were found significant superior over control. The treatment, T_4 showed significantly lower number of mustard aphids *i.e.* 7.48 aphids and gave more protection to rapeseed mustard. The next treatment in order of superiority was T_3. T_7 was the least effective treatment. However, the population in T_9 (standard check) was 2.81 aphids and found more effective over all the treatments. The highest population was found in control (Water spray) with the mean population 75.33 aphids.

The present findings correlate with the finding of Sewak and Sharma (2021), according to them Neem Seed Kernel Extract 5 per cent (NSKE) and Thiamethoxam 0.003 per cent were found to be most effective and significantly different from other treatments in causing pest mortality at 1, 3 and 5 DAS. Acetamiprid 1.5 per cent and DDVP 0.05 per cent were the next most effective insecticides and were statistically at par in causing pest mortality. NSKE 5% was at par with Profenophos 0.05 per cent. Neem oil 1.5 per cent, Chilli + Garlic extract 5 per cent and Neem leaf extract 5 per cent showed more than 50 per cent pest mortality, respectively.

Neem products, like Neemazal T/S and NSKE, exhibit efficacy against mustard aphids due to their active ingredient, azadirachtin, which disrupts aphid feeding behaviour, growth, and reproduction through antifeedant and growth-regulating properties. Additionally, neem formulations may repel aphids from treated plants, while being environmentally friendly with minimal toxicity to non-target organisms and soil health. The residual effects of neem products provide prolonged protection against aphids, reducing the need for frequent pesticide applications. Overall, neem products offer a comprehensive solution for managing mustard aphids by targeting multiple aspects of their biology and behaviour. Singh and Lal (2009) also found that NSKE @ 5% and neem oil @ 2% were found more effective against mustard aphid than Eucalyptus Leaf Extracts @ 5% and Fennel Seed Extract @ 5%. Similar effect was found by Biswas (2008) with the neem extract, reduced comparatively low aphid population than Malataf, but it was not toxic like chemical insecticides. The present findings are in accordance with the finding of Yadav *et al.* (2021) according to them, Dimethoate 30 EC @ 625 ml/ha was proved most effective treatment with pooled mean aphid population of 4.36, 3.85 and 2.83 aphids/10 cm on main apical shoot as against 29.43, 37.37 and 44.77 aphids/10 cm on main apical shoot in the control after 3, 7 and 10 days of spray, respectively. Succeeding treatments, Neem oil @ 5% after clipping of infested twigs, *Beauveria bassiana* @ 10^8 cs/ml after clipping of infested twigs, NSKE @ 5% after clipping of infested twigs, *Beauveria bassiana* @ 10^8 cs/ml, Neem oil @ 5%, NSKE @ 5% and clipping of infested twigs at ETL with pooled mean aphid population of 5.95, 6.32, 7.28, 7.87, 8.43, 8.87 and 32.92 aphids/10 cm of main apical shoot after 10 days of spray, respectively.

The pooled data of yield presented in Table 1 revealed that all the treatments produced higher and significantly more yield over control (7.50 q/ha). The treatment, Neemazal T/S 10,000 ppm @ 0.03% at T_4 produced maximum yield of 12.71 q/ha followed by T_3 (11.94 q/ha). The T_7 (8.46 q/ha) produced the lowest yield among all treatments. The standard check at T_9 produced maximum yield over all the treatments (13.8 q/ha) while 7.50q/ha yield was recorded from control. The pooled data pertaining to economics of various treatments are presented in Table 2 revealed that the highest net return was observed from Neemazal T/S 10,000 ppm @ 0.03% in T_4 (₹23927.33) and the minimum in T_7 (₹3238.58). The cost benefit ratio of different treatments revealed that T_4 (1:9.97) was the most economical treatment followed by T_3 (1:9.28), T_6 (1:8.82), T_1 (1:8.21), T_2 (1:5.36), T_5 (1:3.99) and T_7 (1:2.02). The least cost: benefit ratio (1:1.45) was obtained by Garlic extract @ 5% in T_8. However, standard check (T_9) was found most effective with ₹29851.67 as net return and cost: benefit ratio (1:12.98).

In conclusion, the results demonstrated significant efficacy of various treatments compared to the control, particularly highlighting Neemazal T/S 10,000 ppm @ 0.03% (T_4) as the most consistently effective treatment across multiple observation points. This treatment consistently

exhibited lower mustard aphid populations and provided better protection to rapeseed mustard compared to other tested options. Additionally, the data on yield and economic analysis emphasized the economic viability of using Neemazal T/S 10,000 ppm @ 0.03% (T_4) and NSKE @ 5% (T_3) treatments, showing higher yields and favourable cost-benefit ratios compared to other treatments, including the standard check (T_9), Imidacloprid 17.8 SL @ 0.05%. Overall, these findings underscore the potential of eco-friendly management options, particularly Neem-based products, in controlling mustard aphid infestations while maintaining or even enhancing crop yield and economic returns.

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