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Bio-efficacy of insecticides against mustard aphid (*lipaphis erysimi* Kalt.) on mustard (*Brassica juncea* L.)

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Abstract
The present investigations entitled: "Studies on insect-pests complex in mustard and bio-efficacy of insecticides against major insect-pests" was carried out at Students' Instructional Farm of Narendra Deva University of Agriculture and Technology, Kumarganj, Faizabad during *Rabi*, 2016. All the treatments gave significantly higher yield (010.20-13.00 q/ha) over control (9.67 q/ha). The effect of treatment on seed yield was found higher yield (13.00q/ha) in Emamectin Benzoate @ 0.005%. As compare to other tested treatments. The result showed that all the chemicals had better yield in compression to botanicals. Among botanicals Nimbecidine @ 0.45% gave highest yield which over at par with other botanicals except castor oil. The Effectiveness of treatments was determined based on the population of mustard aphid was recorded one day before spray as pre-treatment observation, while post treatment observations were taken at 3, 7 and 10 days after spray. Application of treatments with botanical and chemical insecticides. Among all insecticides in which Emamectin benzoate @ 50g ai/ha. were found more effective due to minimum insect-pest infestation and resulted significantly more yield over control.

Keywords: Bio-efficacy, insecticides against mustard aphid

1. Introduction
The mustard is an important oilseed crop belongs to the family crucifereae. The oilseed crop plays an important role in agricultural economy of India. India is one of the largest mustard growing countries in the world occupying the third position in area and production after China and Canada with 12 % of world's total production. *Brassica juncea* is the second most important oilseed crop in the country after groundnut and accounts for nearly 30.7% of the total oilseed production in the country. At global level mustard is cultivated on 36.15 million hectare with production of 71.09 MT. Mustard oil production increased from 1.94 Million MT from 2014-15 to 2.11 Million MT in 2015-16. European Union (EU) is expected to be the top producer followed by China and Canada in 2015-16. India may be the fourth largest producer. India's share in global production of mustard oil in 2015-16 may be around 9.0 per cent. The US and China were the leading importing countries of mustard oil in the world. India was the 7th largest importing country in 2014-15. (Anonymous, 2016a) [1]. In India, it had the area of 5.79 million ha. with production of 6.28 MT and productivity of 1083 kg/ha. (Anonymous, 2016b) [2].
There are several insects which cause damage to mustard crops viz., mustard aphid, *Lipaphis erysimi;* mustard saw fly, *Athalia lugens proxima* (Klug.); painted bug, *Bagrada hilaris* (Burm.); pea leaf miner, *Chromatomyia horticola* (Gour.); cabbage butter fly, *Pieris brassicae* (Linn.) and bihar hairy caterpillar, *Spilarctia oblique* (Syn. *Spilosoma obliqua)* (Walker). Mustard aphid is small, globular, pear shaped, delicate insect with soft and fragile body. Adult aphid is found in two forms *i.e*. winged (alate) and other wingless (delate). Wingless adult aphid varies in colour mostly green or pale green and 2 mm long in size. Winged form has transparent homogenous wings and yellowish abdomen. Young ones (nymphs) are like wingless forms but smaller in size. Two tubular structures (cornicles or siphunculi) are present on the posterior region of the body.

2. Method and Material
2.1 Plan of Experiments
The experiments were executed in the field with the procurement of seeds, fertilizers and test

materials like plant product and chemicals well in advance. The variety Narendra Rai (NDR-8501) was procured from the Department of Genetics and Plant Breeding of the University to carry out the present studies. The experiment was laid out by growing a popular variety, Narendra Rai (NDR-8501) in *Rabi* 2016-17. The recommended agronomic practices were followed to raise the crop.

Table 1: Treatments for testing effectiveness against mustard aphid under field conditions

Treat. No.	Treatments	Formulation	Conc. (%)	Source
T_1	NSKE	Solution 100/5	5	Local
T_2	Neem oil	Solution 100/2	2	Local Market
T_3	Castor oil	Solution 100/2	2	Mingu Pharma, Unnao, U.P.
T_4	Karanj oil	Solution 100/2	2	Seed Entomology lab.
T_5	Nimbecidine	0.03%	0.45	T. Stanes Co. Ltd. Coimbatores, Tamilnaidu
T_6	Thiamethoxam	25%WG	50g ai/h.	Krishi Rasayan Exports PVT. LTD. New Delhi 110019
T_7	Emamectin Benzoate	5SG	0.005	Syngenta India Limited Pune-411045, Maharashtra
T_8	Imidacloprid	17.8%SL	0.05	Dhanuka Agritech Limited, Udhampur-182101 (J. & K.)
T_9	Control	Untreated	-	-

2.2.2 Preparation of 5% NSKE

Fresh ripe neem seeds were collected, cleaned and dried in shade and stored in the Laboratory of the Department of Entomology of the University. After removing the seed coat, kernels were crushed and ground into powder with the help of pastle and mortar. In order to prepare 50 per cent NSKE, 250 g ground kernel powder were soaked into 500 ml of water for 24 hours. Thereafter, it was centrifuged at 4000 rpm for 30 minutes and filtered with the help of muslin cloth. The volume of filtrate was made 500 ml by adding water and kept as stock solution for its test under field conditions.

2.3.3 Determination of amount of insecticides

The required amount of insecticides was calculated by using the formula as given below:

$$\text{Required amount of insecticides} = \frac{\text{water (lit. ha.}^{-1}\text{) x Disered concentration (\%)}}{\text{Strength of insecticide formulation (\%)}}$$

The volume of spray solution was diluted by mixing water @ 600 liter ha^{-1}. Spraying solution was prepared as per requirement of both botanical and chemical insecticide based on plat size.

2.4.4 Application of treatments

All treatments were sprayed with the help of Knapsack Sprayer. The care was taken to avoid drift of spray from one plot to another plot by surrounding the plot with polythene sheets as border at the time of spraying.

2.5.5 Pre-treatment and post-treatment Observation

The crop was regularly monitored to record occurrence of aphids up to ETL (50 aphids/10cm central twig/plant at terminal stage of crop). Treatments were applied, when mustard aphids were at ETL. The populations of aphids were recorded one day before treatment and 3, 7 and 10 days after treatment at each application of treatments. The incidences of mustard aphid were recorded on ten randomly selected plants from each plot by following the appropriate method of observation.

The yield was also being recorded from each plot separately to determine the effects of treatment on yield. The data were statistically analyzed to find out the difference among treatments.

2.6 Harvesting and threshing for determination of grain yield

Mustard crop was harvest at maturity, when crop turned golden yellow. Harvesting was done on individual plot basis esxcluding border rows from all sides. Threshing of bundled crop was done separately for each plot. After threshing seed was cleaned and weight for yield of each plots separately.

2.7 Statistical Analysis

The data obtained from the experiment were statistically analyzed in appropriate programme by the Computer with desired transformation ($\sqrt{(X+1/2)}$) in a Randomized Block Design (RBD) as outlined by Gomez and Gomez (1976**)**.

3. Results and Discussion

The population of mustard aphid was observed randomly distributed ranging from 62.67 to 64.67 aphids/ 10 cm central twig/plant prior to application of treatments during *Rabi* 2016-17. The chemical insecticides were more effective than botanical. The present investigation are in accordance with the finding of Rohilla *et al.*, (2004) [4] who reported that evaluated the bio efficacy of 10 insecticides against mustard aphid. Among these, imidacloprid 17.8 SL @ 0.0178 per cent, thiamethoxam (Actara) 25 WG @ 50 g a.i./ha, oxydemeton methyl 25 EC @ 0.025 per cent and monocrotophos 36 EC @ 0.036 per cent proved as most effective insecticide.

The present investigation are in accordance with the finding of Sharma *et al.*, (2012) [6] who reported that evaluated The highest yield was recorded in dimethoate 30 EC @ 300 g a.i. ha-1 (2370 kg ha-1) followed by azadirachtin 1500 ppm 0.1% (2240 kg ha-1), neem oil 2% (2200 kg ha-1), karanj oil 1% (2180 kg ha-1), neem seed kernel extract 5% (2120 kg ha-1), neem oil 1% (2060 kg ha-1), green chilly extract 5% (1970 kg ha-1) and *V. lecanii* @108 conidia ml-1 (1950 kg ha-1) (Table 1).

Singh (2007) found that oxy demeton-methyl 0.025% and NSKE 5% were most effective in reducing the aphid population with higher yield. Singh and Lal (2009) [7] found neem seed kernel extract 5%, neem leaf extract 5% and neem oil 2% to be effective in reducing the mustard aphid population. Kumar and Singh (2009) [7] reported that use of *V. lecanii* alone and also in combination with *C. carnea* and oxy-demeton methyl provided good aphid control.

The present finding in also in partial agreememt with finding of Sachin Kumar and Ashwani Kumar (2016) [5] who revealed that treatments of Dimethoate 30 EC followed by spraying of Malathion 50 EC and Neem oil (0.5%) were found more effective for control of *Lipaphis erysimi* Kalt., respectively. Whereas, the descending order of treatments were Neem oil > NSKE > Tobacco Leaf extract > *Bacillus thuringiensis* > *Beauveria bassiana* > *Metarhizium anisopliae.* The least

effective treatment was *Verticillium lecanii*. Maximum infestation was recorded in control.

All the treatments gave significantly higher yield (010.20-13.00 q/ha) over control (9.67 q/ha).The effect of treatment on seed yield was found higher yield (13.00q/ha) in Emamectin Benzoate @ 0.005%. As compare to other tested treatments. The result showed that all the chemicals had better yield in compression to botanicals. Among botanicals Nimbecidine @ 0.45% gave highest yield which over at par with other botanicals except castor oil. The present investigations are also in partial agreement with the findings of Mandal and Mandal (2010) [3] who reported that Thiamethoxam 25 WG @ 25g ai/ha (10.53q/ha). The present investigations are in accordance with the finding of Patel *et al.* (2017) who reported that imidacloprid @ 17.8 SL (12.36 q/ha).

Table 2: Effectiveness of botanical and chemical insecticides against mustard aphid during *Rabi* 2016-17

Treat. No.	Treatments	Conc. (%)	No. Of spray	Population of mustard aphid (Av. No./10 cm central twig /plant)			
				Pre-treatment*	Post-treatment**		
				1 DBS	3 DAS	7 DAS	10 DAS
T_1	NSKE	5	1	64.67 (8.07)	50.33 (7.13)	24.67 (5.02)	9.67 (3.19)
T_2	Neem oil	2	1	64.33 (8.05)	46.00 (6.82)	22.33 (4.78)	7.00 (2.74)
T_3	Castor oil	2	1	64.33 (8.05)	51.00 (7.18)	26.67 (5.21)	13.33 (3.72)
T_4	Karanj oil	2	1	63.67 (8.01)	47.67 (6.94)	25.33 (5.08)	12.67 (3.63)
T_5	Nimbecidine	0.45	1	64.00 (8.03)	47.33 (6.92)	23.00 (4.85)	6.33 (2.61)
T_6	Thiamethoxam (25 WG)	50g ai/h.	1	62.67 (7.95)	41.00 (6.44)	20.00 (4.53)	4.33 (2.20)
T_7	Emamectin Benzoate (5 SG)	0.005	1	63.33 (7.99)	40.00 (6.36)	17.67 (4.26)	1.00 (1.22)
T_8	Imidacloprid (17.8 SL)	0.05	1	63.00 (7.97)	40.00 (6.36)	18.00 (4.30)	2.00 (1.58)
T_9	Control (water spray)	-	1	63.67 (8.01)	180.00 (13.44)	270.00 (6.45)	347.67 (18.66)
	SEm±	-	-	-	(0.10)	(0.11)	(0.13)
	C.D. (0.5)	-	-	-	(0.31)	(0.34)	(0.40)
	C.V (%)	-	-	-	(2.40)	(3.30)	(5.2)

***** Pre treatment : 1 Day before spray (DBS)
** Post treatment : Day after spray (DAS)
Day of spraying : 02/02/2017
Figures in the parentheses are $\sqrt{X + 0.5}$ transformed values

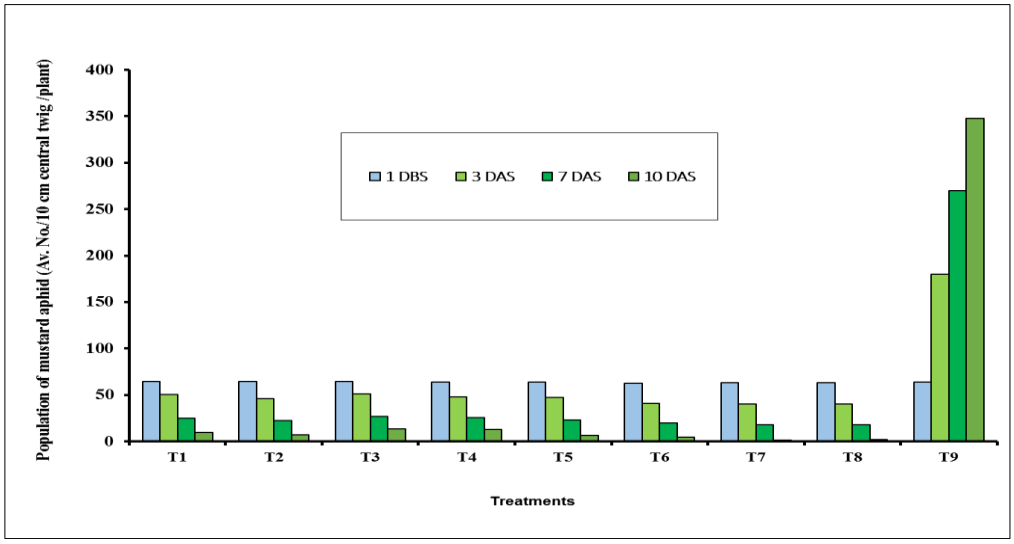

Fig 1: Effectiveness of botanical and chemical insecticides against mustard aphid during *Rabi* 2016-17

Table 3: Effectiveness of treatments based on reduction (%) in population of mustard aphid during *Rabi* 2016-17

Treat. No.	Treatments	Conc. (%)	Reduction %		
			3 DAS	7 DAS	10 DAS
T_1	NSKE	5	22.17 (28.07)	61.85 (51.84)	85.04 (67.22)
T_2	Neem oil	2	28.49 (32.24)	65.28 (53.88)	89.11 (70.49)
T_3	Castor oil	2	20.72 (27.05)	58.54 (49.90)	79.27 (62.90)
T_4	Karanj oil	2	25.14 (30.08)	60.21 (50.91)	80.10 (63.48)
T_5	Nimbecidine	0.45	26.04 (30.67)	64.06 (53.15)	90.10 (71.74)
T_6	Thiamethoxam (25 WG)	50g ai/h.	34.57 (36.00)	68.08 (55.58)	93.09 (74.74)
T_7	Emamectin Benzoate (5SG)	0.005	36.83 (37.35)	72.09 (58.09)	98.42 (82.87)
T_8	Imidacloprid (17.8 SL)	0.05	36.50 (37.15)	71.42 (57.66)	96.82 (79.70)
T_9	Control (water spray)	-	-	-	-
	SEm±	-	0.52	0.41	0.81
	C.D. (0.5)	-	1.59	1.26	2.49
	C.V (%)	-	2.79	1.32	1.97

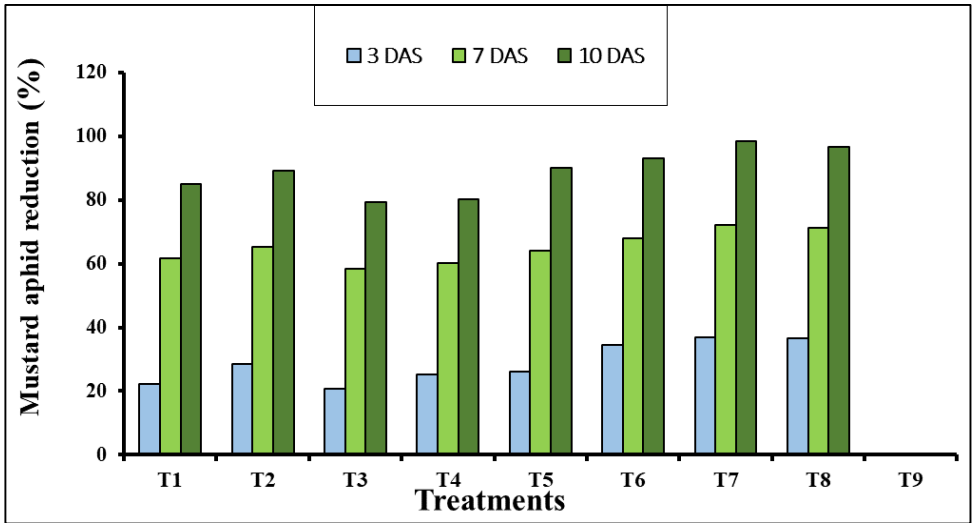

Fig 2: Effectiveness of treatments based on reduction (%) in population of mustard aphid during *Rabi* 2016-17

Table 4: Effect of botanical and chemical insecticides on seed yield of mustard var. NDR-8501 *(Narendra Rai)* during *Rabi* 2016-17

Treat. No.	Treatments	Conc. (%)	Yield		Increase in yield over control (%)
			Kg/ plot	Q/ha	
T_1	NSKE	5	1.325	11.04	14.17
T_2	Neem oil	2	1.350	11.25	16.34
T_3	Castor oil	2	1.225	10.20	5.48
T_4	Karanj oil	2	1.300	10.83	12.00
T_5	Nimbecidine	0.45	1.375	11.45	18.40
T_6	Thiamethoxam (25 WG)	50g ai/h.	1.475	12.29	27.10
T_7	Emamectin Benzoate (5 SG)	0.005	1.560	13.00	34.44
T_8	Imidacloprid (17.8 SL)	0.05	1.500	12.50	29.26
T_9	Control (water spray)	-	1.160	9.67	-
	SEm±	-	0.06	0.32	-
	C.D. (0.5)	-	0.18	0.95	-
	C.V (%)	-	7.7	4.8	-

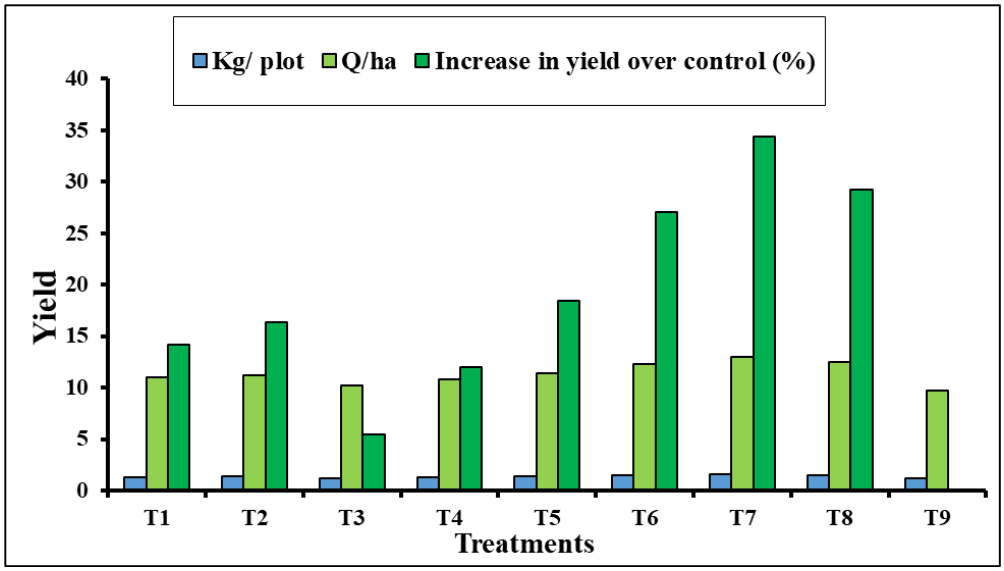

Fig 3: Effect of botanical and chemical insecticides on seed yield of mustard var. NDR-8501 (Narendra Rai) during Rabi 2016-17

4. Conclusion

The effectiveness of treatments was further determined on the basis of cumulative reduction in population of mustard aphid for *Rabi* season 2016-17. Out of three chemical insecticides tested, Emamectin Benzoate @ 0.005% (T_7) with 36.83,72.09 and 98.42% reduction in population of mustard aphid at 3,7 and 10 days respectively, was found as the most effective insecticide followed by Imidacloprid @ 0.05% (T_8) and Thiamethoxam @ 50g a.i./ha. (T_6) against mustard aphid.

All the treatments gave significantly higher yield (010.20-13.00 q/ha) over control (9.67 q/ha). The effect of treatment on seed yield was found higher yield (13.00q/ha) in Emamectin Benzoate @ 0.005%. As compare to other tested treatments. The result showed that all the chemicals had better yield in compression to botanicals. Among botanicals Nimbecidine @ 0.45% gave highest yield which over at par with other botanicals except castor oil.

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