Biological Forum – An International Journal 15(1): 336-340(2023)

ISSN No. (Print): 0975-1130
ISSN No. (Online): 2249-3239

Field Evaluation of Thiamethoxam against Mustard Aphids in Mustard Crop under North Bihar conditions

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(Received: 27 November 2022; Revised: 04 January 2023; Accepted: 10 January, 2023; Published: 17 January, 2023)
(Published by Research Trend)

ABSTRACT: A field trial was conducted at RPCAU, Pusa, Samastipur, Bihar during the *Rabi*, 2021-22. Seven treatments were assessed over mustard aphid, *Lipaphis erysimi* Kaltenbach *i.e.* thiamethoxam 25% WG at different doses at 12.5, 16.67, 25, 37.5, 50 g a.i. per ha, standard check of dimethoate 30% EC at 200 g a.i. per ha and untreated control (water spray). Among the various doses of thiamethoxam sprayed twice at an interval of 10 days on mustard, *Brassica juncea* L., treatments T_5, T_4 and T_3 were statistically at par in terms of their effectiveness *i.e.* 5.95, 6.82 and 8.95 no. of *L. erysimi*/top 10 cm of terminal shoot. It was followed by T_6 (13.29), T_2 (15.41), and T_1 (18.75). The plots treated with thiamethoxam (50 g a.i. per ha) gave highest yield and B:C ratio and it was in line with the results of thiamethoxam 37.5 and 25 g a.i. per ha.

Keywords: Thiamethoxam, mustard, mustard aphids, field bioefficacy.

INTRODUCTION

Oil seed crops play an imperative function in Indian agricultural-based economy. Mustard, *Brassica* sp. (*Cruciferae*), farmed as the Rabi crop, is one of the oilseed crops farmed in India (Singh *et al*., 2018) and major contributor accounting 13 per cent of total consumption of oil worldwide (Giri, 2017). In spite of a diversity of agro-climatic circumstances, along with irrigated/rainfed, timely/late planted, saline soils, and composite farming, it is grown across the country, from the north-eastern/north-western hills to the down south (Pradhan *et al.,* 2020). In India, it is grown on 6.7 million hectares of land, with production of 11.75 million tonnes and productivity of 1524 kg per ha. It is farmed in Bihar on an expanse of 0.08 million hectares, generating 0.10 million tonnes and obtaining yield of 1271 kg per hectare, respectively (Anonymous, 2022).

Mustard is used for various purposes *viz.,* oil, leafy vegetables and seedcake. The leaves contain calcium, copper as well as vitamins- A, C, K and can be eaten in raw or cooked form while their seeds are rich in fiber, selenium, magnesium and manganese. Both seeds and leaves are rich in sinigrin (anti-inflammatory, antibacterial, antifungal, anticancer and wound-healing properties) and isothiocyanates. Mustard is also rich in carotenoids, isorhamnetin, and kaempferol.

From seedlings to harvests, almost 50 insect species in India pose a serious menace to mustard (Sharma and Singh 2010). Out of many insect pests, sawfly (*Athalia lugens proxima* Klug.), leaf miner (*Chromatomyia horticola* Gorreau), painted bug (*Bagrada cruciferarum* Kirk.), flea beetle (*Phyllotreta cruciferae* Goeze), diamond back moth (*Plutella xylostella* L.), cabbage butterfly (*Pieris brassicae* L.), mustard aphid (*Lipaphis erysimi* Kalt.), cabbage aphid (*Brevicoryne brassicae* L.) and green peach aphid (*Myzus persicae* Sulzer) are considered important causing economic yield losses (Patel *et al.,* 2019). In all mustard-growing countries, the predominant pest is *L. erysimi*. The aphid's nymphs and adults suck cell sap from leaves, stems, twigs, buds, inflorescences, and immature pods, which has a highly deleterious effect on pod setting and production. Nevertheless, aphids secrete honeydew which further causes sooty mould growth, which turns the foliage and pod's appearance filthy black and eventually hampers photosynthetic activity (Awasthi, 2002). For escaping from the aphid infestation in the mustard crop, there should be asynchronization of the vulnerable stages of the crop and the period of multiplication activity of aphids (Saljoqi *et al.,* 2011). Infestations of aphids peaked from the end of December to the first week in March, according to Patel *et al.* (2019). Hence, if mustard crops are planted early, an infestation can be avoided (Mishra and Gaurav 2022; Saxena and Murthy 2014).

Aphid infestation might diminish oil content by 5 to 6 per cent (Shylesha *et al*., 2006) and potentially trigger economic output losses amounting to 96 per cent (Patel *et al.,* 2019). The *L. erysimi* is acknowledged as a nationwide pest attributable to its economic importance (Rao *et al.,* 2014). Verma (2000) documented a yield loss of 96 per cent; Bakhetia and Sekhon (1989) observed yield losses as 11.6 to 39.0 per cent; Chauhan and Chauhan (2005) found a loss of 14.0 to 27.9 per cent; and Kular and Kumar (2011) stated a loss of 6.5 to 26.4 per cent; Mukherjee and Singh (2017) estimated the yield losses > 30 per cent. However, Sharma *et al.* (2019) study concludes that for all *Brassica* spp. the mean oil content on late sowing was considerably lower in unprotected plots *i.e.* 38.1 to 38.6 per cent than in protected plots 40.59 to 41.48 per cent.

Insecticides from a more recent generation have lower toxicity toward non-target species, stronger efficacy against the pests they are intended to control, and are not as tenacious as earlier insecticides. Thiamethoxam, a neonicotinoid, is widely used against sucking pests in various crops including mustard (Giri *et al.,* 2017). The efficacy of thiamethoxam in combating mustard aphids is asserted by its broad-spectrum, systemic nature and may be supported by the results of Dhillon *et al.* (2022); Sharma *et al.* (2020); Lal *et al.* (2018); Maurya *et al.* (2018); Shankarganesh *et al.* (2015); Kumar *et al.* (2013). Chemical management is the most effective strategy since the mustard aphid multiplies and spreads quickly in a short amount of time under favourable climatic circumstances. In light of this, the current interpretation was employed to analyze thiamethoxam's field evaluation against mustard aphids in mustard crop under North Bihar conditions.

MATERIALS AND METHODS

A field experiment was conducted at RPCAU, Pusa, Bihar, India in a Randomized Block Design (RBD) to study the thiamethoxam's field evaluation against aphids, *Lipaphis erysimi* in mustard crop under North Bihar conditions during *Rabi,* 2021-22 with seven treatments *viz.,* T_1) Thiamethoxam 25% WG @ 12.50 g a.i. per ha; T_2) Thiamethoxam 25% WG @ 16.67 g a.i. per ha; T_3) Thiamethoxam 25% WG @ 25 g a.i. per ha; T_4) Thiamethoxam 25% WG @ 37.50 g a.i. per ha; T_5) Thiamethoxam 25% WG @ 50 g a.i. per ha; T_6) Dimethoate 30 % EC @ 200 g a.i per ha (Check); T_7) Control (water spray) is having each treatment area of $27m^2$ with three replications. Sowing of the mustard crop, Rajendra Sufalam variety was done in October, 2021 according to the standard recommended agronomic practices. Spray solution was calculated with 500 litre of water for one spray for one hectare and in total, two sprays were given with a gap of 10 days. The first application was given when the pest population reached at Economic Threshold Level (ETL). Spraying was done by using knapsack sprayer.

For identification of the mustard aphids, five plants were chosen randomly and tagged. The population of nymphs and adults of aphids were counted from the top 10 centimeters central twig of those plants that were pre-selected. The sightings were identified one day after the first spray (pre-count) as well as after one, three, seven and ten days following every spray. After threshing and sorting the mustard seeds from each plot, the yields were calculated. Per plot's yield was weighted independently and converted to kilograms per hectare then it was analyzed statistically. To combat mustard aphids, the benefit-cost ratio (B: C) of several treatments was computed.

The data on the mustard aphid population in different treatments were subjected to Analysis of Variance (ANOVA) following Randomized Block Design (RBD) using the statistical software OPSTAT (Sheoran *et al.,* 1998). The level of significance was set at 5%.

RESULTS AND DISCUSSION

The incidence of mustard aphid, before and after two sprays of insecticidal treatments in 2021-22 are illustrated in Table 1. The nymphs and adults aphid population prior to spraying was 92.53-102.93 per top 10 cm terminal shoot. After the first insecticidal application, aphids population was significantly reduced in all the treated plots, but augmented in control plots. Three days after 1st application of insecticides spray, results showed that the thiamethoxam (50 g a.i. per ha) treated plot had the least *L. erysimi* (8.47 aphids) followed by thiamethoxam at 37.5 g a.i. per ha (11.20) and thiamethoxam at 25 g a.i. per ha (12.90). Comparatively less effective treatments were dimethoate at 200 g a.i. per ha (18.73) followed by thiamethoxam at 16.67 g a.i. per ha (25.93) and thiamethoxam at 12.5 g a.i. per ha (21.41). Seven days after 1st spray application, again least *L. erysimi* plot was thiamethoxam 50, 37.5 and 25 g a.i. per ha (1.95, 2.20 and 5.53). Furthermore followed by dimethoate at 200 g a.i. per ha (9.73 aphids), thiamethoxam at 16.67 g a.i. per ha (13.20) and thiamethoxam at 12.5 g a.i. per ha (17.80). After ten days of 1st spray treatment, the population of aphids was increased in all the treatments except in contrast the higher doses of thiamethoxam at 37.5 and 50 g a.i. per ha where the population was reduced. Hence, there was a need to go for the second spray application of the same insecticides.

After the 2nd spraying was done, one day after 2nd spray, it was noticed that the aphid population was least in thiamethoxam at 50 and 37.5 g a.i per ha i.e. 0.33 and 0.80 followed by thiamethoxam at 25g a.i per ha (2.40) which was statistically at par. Comparatively less effective treatments were dimethoate at 200 g a.i. per ha (8.52) followed by thiamethoxam at 16.67 g a.i per ha (7.21) and 12.5 g a.i per ha (10.41). Three days after 2nd spray appliance, it was reflected in line with the one-day post-application in terms of efficacy, again thiamethoxam at 50 g a.i per ha (0.00) showed a significant reduction in aphid population followed by thiamethoxam at 37.5 g a.i per ha (0.53) and 25g a.i per ha (1.57). Again the comparatively less effective treatments were dimethoate at 200 g a.i. per ha (3.08 aphids) followed by thiamethoxam at 16.67 g a.i per ha (5.71) and 12.5 g a.i per ha (6.13). Seven and ten days after the 2nd spray post-appliance, the same trend was followed. Hence the order of efficacy of these treatments was T_3 – thiamethoxam 25 WG @ 50 g a.i. per ha > T_4 -thiamethoxam 25 WG @ 37.5 g a.i. per ha >T_5-thiamethoxam 25 WG @ 25 g a.i. per ha > T_6 - dimethoate 30 EC @ 200 g a.i. per ha> T_2- thiamethoxam 25 WG @ 16.67 g a.i. per ha > T_1 - thiamethoxam 25 WG @ 12.5 g a.i. per ha.

The findings of Kumar *et al.* (2022) were comparable to the current observation, which suggested that thiamethoxam 25 WG @ 100 g per ha gave 94.9% reduction and was effective in the treatment of aphids and thiamethoxam 25WG @ 50 g per ha resulted in 71.3% reduction. Din *et al.* (2022) work also supported and they too recorded the lowest no. of aphids in plots treated with thiamethoxam 25 WG @ 100 g per ha in both mustard cultivars *i.e* China (8.49) and Swabi (19.72). The current outcomes were also supported by Kumar (2021) who stated that thiamethoxam 25WG @ 0.2g/ liter water (4.8 aphids/ 10cm central twig) and dimethoate 30 EC @ 1ml/ liter of water (23.6 aphids/ 10 cm central twig) were effective in controlling *L.erysimi.* Additionally, the outcomes of this investigation are in line with Raju and Tayde (2022) who on spraying thiamethoxam 25% WG @ 0.25 g/ lit recorded 33.63 aphids over control (171.96). The conclusions were drawn by Sharma *et al.* (2020); Patel *et al.* (2020); Vishal *et al.* (2019); Dwivedi and Singh (2019); Maurya *et al.* (2018); Lal *et al.* (2018); Vishvendra *et al.* (2018); Kumar *et al.* (2018); Patel *et al.* (2017); Kumar *et al.* (2017); Singh *et al.* (2017); Sen *et al.* (2017) aligned with the current outcomes which say that thiamethoxam 25 WG was most effective in controlling of mustard aphids as well as they have reported the efficacy of dimethoate over aphids.

The data on yield (Kg/ha) is presented in (Table 1) implied that post insecticidal application and the yields were varied significantly from 1172.84 to 1470.74 Kg/ha. The lowest seed yield was reported in control plot yields of 1001.80 Kg/ ha.

Table 1: Efficacy of insecticides against mustard aphids, *Rabi* 2021-22.

Treatments	Number of nymphs and adults of aphids/ top 10 cm shoot												Yield (Kg/ ha)	B: C ratio
	1st spray						2nd spray					Overall Mean		
	Pre count	1 DAS	3 DAS	7 DAS	10 DAS	Mean	1 DAS	3 DAS	7 DAS	10 DAS	Mean			
T_1 - Thiamethoxam 25% WG @ 12.50 g a.i/ ha	95.40^{a} (9.82)	56.67^{e} (7.59)	25.93^{c} (5.19)	17.80^{d} (4.34)	23.67^{d} (4.97)	31.02^{d} (5.66)	10.41^{c} (3.38)	6.13^{b} (2.67)	5.14^{b} (2.48)	4.27^{b} (2.30)	6.49^{b} (2.74)	18.75^{c} (4.44)	1172.84	3.384:1
T_2 - Thiamethoxam 25% WG @ 16.67 g a.i/ ha	95.73^{a} (9.84)	49.80^{d} (7.13)	21.41^{bc} (4.73)	13.20^{cd} (3.77)	17.07^{c} (4.25)	25.37^{c} (5.14)	7.21^{bc} (2.87)	5.71^{b} (2.59)	4.96^{b} (2.44)	3.89^{b} (2.21)	5.44^{b} (2.54)	15.41^{bc} (4.05)	1219.75	4.513:1
T_3 - Thiamethoxam 25% WG @ 25 g a.i/ ha	94.40^{a} (9.77)	42.60^{bc} (6.60)	12.90^{a} (3.73)	5.53^{ab} (2.56)	6.39^{b} (2.72)	16.86^{b} (4.23)	2.40^{ab} (1.84)	1.57^{a} (1.60)	0.22^{a} (1.11)	0.00^{a} (1.00)	1.05^{a} (1.43)	8.95^{a} (3.15)	1405.06	8.946:1
T_4 - Thiamethoxam 25% WG @ 37.50 g a.i/ ha	96.07^{a} (9.85)	38.07^{ab} (6.25)	11.20^{a} (3.49)	2.20^{a} (1.79)	1.74^{ab} (1.65)	13.30^{ab} (3.78)	0.80^{a} (1.34)	0.53^{a} (1.24)	0.00^{a} (1.00)	0.00^{a} (1.00)	0.33^{a} (1.15)	6.82^{a} (2.80)	1432.04	9.228:1
T_5 - Thiamethoxam 25% WG @ 50 g a.i/ ha	99.40^{a} (10.02)	36.40^{a} (6.12)	8.47^{a} (3.08)	1.95^{a} (1.72)	0.47^{a} (1.21)	11.82^{a} (3.58)	0.33^{a} (1.15)	0.00^{a} (1.00)	0.00^{a} (1.00)	0.00^{a} (1.00)	0.08^{a} (1.04)	5.95^{a} (2.64)	1470.74	9.757:1
T_6 -Dimethoate 30 % EC @ 200 g a.i/ ha	102.93^{a} (10.19)	45.53^{cd} (6.82)	18.73^{b} (4.44)	9.73^{bc} (3.28)	16.20^{c} (4.15)	22.55^{c} (4.85)	8.52^{c} (3.08)	3.08^{ab} (2.02)	2.69^{ab} (1.92)	1.82^{ab} (1.68)	4.03^{ab} (2.24)	13.29^{b} (3.78)	1278.40	4.875:1
T_7 -Control (Water spray)	92.53^{a} (9.67)	98.30^{f} (9.96)	108.93^{d} (10.48)	130.53^{e} (11.47)	158.53^{e} (12.63)	124.08^{e} (11.18)	163.53^{d} (12.83)	178.87^{c} (13.41)	190.80^{c} (13.85)	205.97^{c} (14.39)	184.79^{c} (13.63)	154.43^{d} (12.47)	1001.80	--
F-test	NS	S	S	S	S	S	S	S	S	S	S	S	--	--
SEm±	3.395	1.846	1.810	1.522	1.733	1.455	1.737	1.082	1.326	1.040	1.256	1.299	--	--
C.D (0.05)	N/A	5.751	5.640	4.742	5.398	4.532	5.411	3.370	4.132	3.240	3.913	4.047	--	--
C.V	6.086	6.092	10.574	10.198	9.376	7.199	10.900	6.694	7.890	6.840	7.531	7.043	--	--
NS- Non significant; S- Significant; DAS- Days After Spray; Figures in parenthesis are square root transformed values														

The highest seed yield was observed in thiamethoxam at 50 g a.i. per ha (1470.74 Kg/ ha) followed by thiamethoxam at 37.5 g a.i. per ha (1432.04 Kg/ha) and 25 g a.i. per ha (1405.06 Kg/ ha). Despite the fact, that has proven that the greatest dose of thiamethoxam 25 WG at 50 g a.i per ha, was the best treatment for enhancing commercial output, the statistically equivalent dose of 25 g a.i per ha would represent the optimal dose while considering economic as well as prudent usage.

Consequently, it may be ascertained, thiamethoxam 25 WG at 25 g a.i. per ha for limiting the mustard aphid. Kumar (2021) reported the highest seed yield of mustard with thiamethoxam 25 WG @ 0.2 g per liter (1925 kg per ha). This is in line with Kumar *et al.* (2022) who obtained good yields on treatment with thiamethoxam 25 WG @100 g per ha and 50 g per ha. The present results were supported by Sharma *et al.* (2020) who applied thiamethoxam 25 WG (25 g a.i per ha) and obtained a seed yield of 1370 kg per ha.

Among the various tested insecticides cited in the Table.1 it is observed that thiamethoxam at 50 g a.i. per ha (9.757:1), 37.5 g a.i. per ha (9.228:1) and 25 g a.i. per ha (8.946:1) have good benefits out of the cost incurred followed by dimethoate at 200 g a.i. per ha (4.875:1), thiamethoxam at 37.5 g a.i. per ha (1.4513:1) and 12.5 g a.i. per ha (3.384:1). This was supported by the findings of Patel *et al.* (2020).

CONCLUSION

On brief account of the field evaluation carried out, to cope with the rapidly multiplying aphid population, the insecticidal application would reduce the populations drastically over the control plots. Keeping this in view, firstly we have to follow the practices that would reduce the insecticidal application, and the fact that early sowing would reduce mustard aphid population should be kept in mind while planting. Under unavoidable circumstances like late harvesting of the earlier crop, labour unavailability and tillage practices, even though it is sown lately go for recommended rate of insecticidal applications to avoid judicious usage. Although the highest yield, economics, and lowest aphid population were encountered in plots treated by thiamethoxam 25 WG @ 50 g a.i. per ha followed by 37.5 g a.i. per ha and 25 g a.i. per ha. But, keeping in view of the economic and judicious usage of the insecticides, thiamethoxam 25 WG @ 25 g a.i. per ha could be employed in obtaining good seed yields as well as reducing aphid populations.

FUTURE SCOPE

To recommend the correct time *i.e.* after the pest population reaches economic threshold level (ETL), the dosage of the insecticides and avoid haphazard and judicious usage of insecticides to protect the natural enemies in the fields.

Acknowledgements. I, kindly acknowledge the Professor & Head, Department of Entomology, Post Graduate College of Agriculture, Dr. Rajendra Prasad Central Agricultural University, Pusa, Bihar for providing the necessary facilities during my research and financial support from the SRF fellowship awarded by ICAR.

Conflict of Interest. None.

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How to cite this article: B. Sujatha, Sanjay Kumar Sahoo and Gouri Shankar Giri (2023). Field Evaluation of Thiamethoxam against Mustard Aphids in Mustard Crop under North Bihar conditions. *Biological Forum – An International Journal, 15*(1): 336-340.