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Efficacy of flonicamid against potato aphids under North Gujarat condition

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Abstract
A field experiment was conducted at Potato Research Station, S. D. Agricultural University, Deesa during 2018-19 and 2019-20 for evaluation of efficacy of two most popular insecticides against aphid in potato. The five different treatments *viz.* T_1- water spray (Untreated), T_2- Foliar spray of Imidacloprid 17.8 SL @ 30 g ai ha^{-1}, T_3-Foliar sprays of Imidacloprid 17.8 SL@ 30 g ai ha^{-1}+ repeat at 15 days, T_4-Single foliar spray of Flonicamid 50 WG @ 75 g ai ha^{-1}, T_5-Foliar spray of Flonicamid 50 WG @ 75 g ai ha^{-1} + repeat at 15 days were evaluated. Based on pooled data of two years, the result revealed that maximum aphid mortality (87.17 %) after third spray was observed with foliar sprays of flonicamid 50 WG @ 75 g ai ha^{-1} + repeat at 15 days followed by imidacloprid 17.8 SL @ 30 g ai ha^{-1} + repeat 15 days (68.03%). The tuber yield was also recorded higher with flonicamid (60.31 t ha^{-1}) followed by imidacloprid (58.43 t ha^{-1}) as compared to control.

Keywords: Aphid, flonicamid, imidacloprid, potato, North Gujarat and tuber yield

Introduction
Potato (*Solanum tuberosum* L.) belongs to family *Solanaceae* and is one of the most important staple food and cash vegetable crops grown in all climatic zones of the world and is next only to wheat, rice and maize in terms of total food production. Potato is considered "The king" in food staples and hardly any domestic kitchen is available which does not use it one or other form as it possesses all the attributes to be potential food crop. It is known as a healthful food and added in human diet in the world as it contains richest source of energy. Potato is widely planted in China, Russia, India, Ukraine, US and other countries. In India 85% area of potato is cover under Uttar Pradesh, West Bengal, Bihar, Madhya Pradesh, Assam, Gujarat and Punjab states. In Gujarat 75% area of potato cover under Banaskatha, Aravalli and sabarkantha. In Gujarat it is harvested in 90 days after planting with bulky yield (30-40 tons/ha) hence it highly adapted vegetable crop by farmers as well as well fitted in cropping sequence. Many insect pests of potato are potential vectors of potato viruses, but aphids are the most important, vectoring 13 of the 40 reported viruses known to infect potato (Salazar 1996). Aphid play vital role in deteriorate the potato seed quality. Among the various insects, aphids have become a threat to crop. It affects the crop by directly sucking the sap from tender parts of plant and also acting as vector in transmitting number of viruses, thereby reducing the tuber yield (Dharpure, 2002 and Bhatnagar, 2013) [4, 1]. Potato (*Solanum tuberosum* L.) is one of the most important food sources on the planet, and several aphid species, e.g., *Myzus persicae* (Sulzer) (green peach aphid) and *Macrosiphum euphorbiae* (Thomas) (potato aphid) (Hemiptera: Aphididae) colonize potato and transmit several economically important viruses. Aphid-transmitted potato viruses have been emerging all over the world as a very serious problem in potato production, inducing a wide variety of foliar and tuber symptoms, leading to severe yield reduction and loss of tuber quality (Xu *et al.* 2020) [10]. Flonicamid is a pyridine organic compound used as an insecticide on aphids, whiteflies, and thrips. It rapidly inhibits the feeding behaviour of aphids and has better action through ingestion than by contact. Under favourable weather conditions the aphids can be extremely injurious as these occur in large numbers and then can only be managed by chemicals. Recently, many new insecticides have been launched with high efficacy and novel mode of action. Inadequate information is available on their efficacy against aphid complex attacking potato. Hence, the present study was taken up to find out the field efficacy of the newer insecticides for the management of aphid in potato.

Materials and Methods

The field trials were conducted to study the efficacy of insecticides for the management of aphids in potato for two consecutive years *Rabi* 2018-19 and 2019-20 at Potato Research Station, S. D. Agricultural University, Deesa. The experiment was laid out in a randomized block design with five treatments including untreated control with five replications. The planting was done at row spacing of 50 cm and plant to plant spacing of 20 cm. The recommended dosage of fertilizers 275 kg N, 138 kg P and 275 kg K per hectare was applied. Insecticides were sprayed using high volume knapsack sprayer with 500 L ha^{-1} solution. Observations of aphid population were recorded one day before spraying (pre-treatment count) and after 2, 4 and 6 day of the spray on 5 tagged plants (3 leaves lower, middle and upper) as per method described by Heathcote (1972) [6]. The Treatment were:

Treatment details

T_1	:	Control (no pesticide application).
T_2	:	Single foliar spray of imidacloprid 17.8 SL @ 30 g ai ha^{-1}
T_3	:	Foliar sprays of imidacloprid 17.8 SL @ 30 g ai ha^{-1} + repeat at 15 days
T_4	:	Single foliar spray of flonicamid 50 WG @ 75 g ai ha^{-1}
T_5	:	Foliar sprays of flonicamid 50 WG @ 75 g ai ha^{-1} + repeat at 15 days

Result and discussion

It was observed that there were non-significant differences in aphid counts in all the treatment before first spray (Table 1). Result revealed that all the treatments significantly reduced aphid infestation. The significantly highest mortality percentage (71.73%) after first spray was recorded in T_4 *i.e.* foliar spray of flonicamid 50 WG @ 75 g ai ha^{-1} which was at par with T_5 *i.e.* foliar spray of flonicamid 50 WG @ 75 g ai ha^{-1} + repeat at 15 days (68.30%). The next best treatment in sequence was T_2 *i.e.*foliar sprays of Imidacloprid 17.8 SL@ 30 g ai ha^{-1} + repeat at 15 days (57.84%) which was at par with T_3 *i.e.*Foliar spray of Imidacloprid 17.8 SL @ 30 g ai ha^{-1} (56.66%).

The significantly highest mortality percentage (77.74%) after second spray was recorded in T_5 *i.e.* Single foliar spray of flonicamid 50 WG @ 75 g ai ha^{-1} + repeat at 15 days which was followed by T_3 *i.e.*Foliar spray of Imidacloprid 17.8 SL @ 30 g ai ha^{-1} + repeat at 15 days (64.16%). (Table: 2). The similar trend was also observed after third spray (Table: 3).

Maximum Incremental Cost: Benefit Ratio (ICBR 1:2.91) was found with flonicamid 50 WG @ 75 g ai ha^{-1} + repeat at 15 days and imidacloprid 17.8 SL @ 75 g ai ha^{-1} + repeat at 15 days as compared to control (ICBR 1:2.20) (Table 4).

Present results are in agreement with findings of Yadav (2022) [11] they reported that maximum aphid mortality (94.0%) and highest tuber yield (25.81 t ha^{-1}) was observed with two foliar sprays of flonicamid 50 WG @ 75 g ai ha−1 followed by imidacloprid 17.8 SL @ 75 g ai ha^{-1}. Results confirmed with findings of Ghelani *et al.* (2014) [5] reported that flonicamid was very effective for the control of aphids. Masayuki Morita *et al*. (2007) [7] reported that flonicamid is very active against aphids, regardless of differences in species, stages and morphs. They also reported that flonicamid compound inhibited the feeding behaviour of aphids within 0.5 h of treatment without noticeable poisoning symptoms such as convulsion and this antifeeding activity was not recoverable until death. The nymphs born from adults exposed to flonicamid for 3 h showed high mortality. Similar result was also reported by Chandi and Gill (2019) [2]. They reported that minimum population of aphid and highest seed yield (11.30 q/ha) was obtained on celery with application of flonicamid 50 WG @ 200 g/ha which was statistically at par with imidacloprid 200 SL @ 100 and 125 ml/ha, thiamethoxam 25 WG @ 100 and 125 g/ha. Dhananjay *et al*. (2018) [3] also reported that the imidacloprid 17.8 SL (150 ml/ha) followed by Thiamethoxam (100 g/ha) at 15 days interval was most effective against sucking pest with least population of aphids (1.91 per plant) and whiteflies (1.56 per plant) in potato. Pawar and Bharpoda (2014) [8] also observed imidacloprid most effective against aphid in safflower.

Table 1: Efficacy of insecticide against potato aphid after first spray during 2018-19 and 2019-20.

Treat-ment	1st Spray					
	Nos before spray			Mortality (%) after spray		
	2018-19	2019-20	Pooled	2018-19	2019-20	Pooled
T_1	**42.44 *(45.60)	35.99 (34.60)	39.27 (40.10)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
T_2	40.82 (42.80)	36.46 (35.40)	38.68 (39.10)	48.49 (55.99)	50.60 (59.68)	48.52 (57.84)
T_3	43.94 (48.20)	35.23 (33.40)	39.68 (40.80)	49.15 (57.23)	48.55 (56.09)	48.84 (56.66)
T_4	45.21 (50.40)	38.37 (38.60)	41.82 (44.50)	56.39 (69.38)	59.42 (74.07)	57.87 (71.73)
T_5	44.40 (49.00)	36.35 (35.20)	40.42 (42.10)	54.29 (65.88)	57.24 (70.71)	55.71 (68.30)
SEd	238	1.61	1.35	2.34	2.66	1.91
CD (0.05)	NS	NS	NS	5.00	5.69	4.09
CV (%)	8.68	7.00	5.36	8.88	9.75	7.14

Table 2: Efficacy of insecticide against potato aphid after second spray during 2018-19 and 2019-20.

Treat-ment	2nd Spray					
	Nos before spray			Mortality (%) after spray		
	2018-19	2019-20	Pooled	2018-19	2019-20	Pooled
T_1	**52.33 *(62.60)	52.89 (63.60)	52.59 (63.10)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
T_2	23.80 (16.40)	20.72 (12.60)	22.31 (14.50)	16.97 (8.81)	16.53 (8.15)	16.83 (8.48)
T_3	24.82 (17.80)	21.57 (13.60)	23.25 (15.70)	51.35 (60.93)	55.27 (67.39)	53.22 (64.16)
T_4	21.07 (13.00)	17.60 (9.20)	19.42 (11.10)	30.76 (27.01)	22.58 (14.94)	26.95 (20.97)
T_5	21.76 (13.80)	17.80 (9.40)	19.90 (11.60)	58.62 (72.54)	65.81 (82.94)	61.89 (77.74)
SEd	1.76	1.13	1.07	3.26	1.94	1.96
CD (0.05)	3.76	2.42	2.30	6.96	4.16	4.20
CV (%)	9.66	6.86	6.17	16.32	9.59	9.78

Table 3: Efficacy of insecticide against potato aphid after third spray during 2018-19 and 2019-20.

Treat-ment	3rd Spray					
	Nos before spray			Mortality (%) after spray		
	2018-19	2019-20	Pooled	2018-19	2019-20	Pooled
T_1	**66.97 *(83.40)	65.13 (82.20)	65.74 (82.80)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
T_2	27.58 (21.60)	22.54 (14.80)	25.18 (18.20)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
T_3	18.94 (10.60)	13.63 (5.60)	16.51 (8.10)	52.22 (62.45)	59.56 (73.62)	55.69 (68.03)
T_4	19.64 (11.40)	18.40 (10.00)	19.04 (10.70)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
T_5	12.89 (5.00)	9.54 (2.80)	11.37 (3.90)	71.62 (84.33)	80.99 (90.00)	74.12 (87.17)
SEd	2.91	1.20	1.59	4.77	5.66	4.72
CD (0.05)	6.22	2.58	3.40	10.19	12.11	10.09
CV (%)	15.76	7.37	9.12	30.42	31.85	28.74

Table 4: Economics of the treatments (pooled data)

Treatments	Yield (t/ha) pooled	Cost of cultivation (Rs./ha)	Produce (Rs./ha)	Sale Price (Rs./t)	Net returns (Rs./ha)	B:C ratio
T_1	47.56	133900	428079	9000	294179	2.20
T_2	53.76	134150	483803	9000	349653	2.61
T_3	58.43	134550	525908	9000	391358	2.91
T_4	54.76	135525	492872	9000	357347	2.64
T_5	60.31	138775	542768	9000	403993	2.91

Conclusion

From the present study, it is concluded that foliar spray of flonicamid 50 WG @ 75 g ai ha^{-1} at 15 days interval for the management of potato aphid and higher net returns.

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