Indian Journal of Entomology Online published Ref. No. e21014 DoI.: 10.5958/0974-8172.2021.00154.1

EFFICACY OF SOIL INSECTICIDES AGAINST SUCKING PESTS OF POTATO

Mohd Abas Shah*, Subhash Katare[1], Anuj Bhatnagar[2], Sanjeev Sharma[3], Murlidhar J. Sadawarti[1] and Shiv Pratap Singh[3]

ICAR-Central Potato Research Institute (CPRI)- Regional Station, Jalandhar 144003, Punjab, India
[1]ICAR-CPRI- Regional Station, Gwalior 474020, Madhya Pradesh, India
[2]ICAR-CPRI- Regional Station, Modipuram 250110, Uttar Pradesh, India
[3]ICAR-CPRI, Shimla 171001, Himachal Pradesh, India
*Email: mabas.shah@icar.gov.in (corresponding author)

ABSTRACT

Field experiments were conducted at three locations for two seasons, 2018 to 2020 to evaluate the efficacy of soil insecticides against sucking pests of potato. Lowest cumulative mean number of whiteflies was observed with fipronil 0.3G @ 25 kg/ ha, and it was on par with its dose of 20 kg/ ha, cartap hydrochloride 4G @ 20 and @ 25 kg/ ha; overall reduction in whiteflies over control ranged between 56.70 and 59.04% at Jalandhar; 53.17 to 60.89% at Modipuram, and 57.33 to 62.40% at Gwalior. Similar trends were noted for aphids, leaf hoppers and thrips. Based on tuber yield and benefit cost ratio, cartap hydrochloride 4G @ 20 kg/ ha (2.62) and fipronil 0.3G @ 20 kg/ ha (2.47) were found to be the most effective against the sucking pests of potato. Hence, both these can be recommended in potato in place of phorate 10G.

Key words: Systemic insecticides, *Bemisia tabaci*, *Empoasca* spp., seed potato, cartap hydrochloride, fipronil, phorate, granular formulations, viruses, tuber yield

Potato crops are infested by a number of insect pests which can cause substantial reduction in tuber yield. Among the sucking pests, aphids and whiteflies are the most important, as these inflict major damage by transmission of viruses limiting disease free seed production with a progressive decline in yield. More than 15 species of aphids are known to infest potato in India (Bhatnagar et al., 2018), along with cotton whitefly *Bemisia tabaci* (Gennadius) (Shah et al., 2019). In addition, leafhoppers such as the potato leaf hopper (*Empoasca devastans* Distant, *E. fabae* Harris), cotton leafhopper (*Amrasca biguttula biguttula* (Ishida)) and thrips (*Thrips palmi* Karny) cause substantial damage (Bhatnagar, 2007; 2008). The incidence of leaf hoppers and thrips is higher in warmer areas and in early season potato crops. These sucking pests have been managed with systemic insecticides. Other than the foliar applications, soil application of phorate 10G leads to significant reduction in the incidence of sucking pests (Nirula, 1962; Nirula and Kumar, 1969; Rizvi et al., 1976). Among the new pesticides suitable for soil incorporation, cartap hydrochloride and fipronil are gaining popularity. Due to continued use of phorate 10G, its efficacy has been found to be not up to the mark. Hence, this study evaluated cartap hydrochloride and fipronil granular formulations against the major sucking pests of potato.

MATERIALS AND METHODS

Field experiments were conducted at three locations namely, Jalandhar (Punjab; 31°16’34” N, 75°32’55” E), Modipuram (Meerut, Uttar Pradesh; 29°04’24” N, 77°42’25” E) and Gwalior (Madhya Pradesh; 26°16’53” N, 78°13’00” E) for two seasons, 2018-19 and 2019-20. Experiments were laid out in randomised complete block design, with eight treatments and three replications. The treatments included cartap hydrochloride 4G @ 15, 20 and 25 kg/ ha, fipronil 0.3G @ 15, 20, 25 kg/ ha, and phorate 10G @ 15 kg/ ha along with untreated control. At Jalandhar, efficacy of the insecticides was evaluated against the cotton whitefly and aphids (various species); against the cotton whitefly and leafhoppers at Modipuram; and against the cotton whitefly and thrips at Gwalior. These were applied once at the time of earthing-up, 30 days after planting. The control treatment was without soil application of insecticides. The crops were raised following the recommended package of agronomic practices without any other crop protection measures.

Observations on the number of insects i.e. adult whiteflies, adults, 3rd and 4th instar nymphs of aphids, and adults and pre-adult nymphs of leaf/ hoppers and thrips were taken from five randomly selected plants/ plot (plot size 3.6 x 3.2 m) one day before treatment

(pre-count) and 3, 5, 10, 20, 30 and 40 days after soil incorporation of insecticides. The per cent reduction in pest population size over control was calculated using the Henderson-Tilton formula (Henderson and Tilton, 1955). The total tuber yield in all experiments was recorded on whole plot basis. The data on number of insects, % reduction over control and tuber yield were subjected to ANOVA after appropriate transformation. The treatment means were separated by least significant difference (LSD, p=0.05).

For benefit cost analysis, the cost of insecticide application was calculated as cost of insecticide and labour units required for its incorporation while as the price of harvested potato was calculated as per the prevailing market rate. Benefit cost ratio was calculated using the following formula-

$$\text{Benefit - Cost ratio} = \frac{\text{Net return (Rs/ ha)}}{\text{Cost of treatment (Rs/ ha)}}$$

RESULTS AND DISCUSSION

Bemisia tabaci: The effect of soil incorporated insecticides on the incidence of whitefly was evaluated at all the three locations (Jalandhar, Modipuram and Gwalior) over the two seasons (2018-19 and 219-20). The effect of insecticide treatments was significant on the incidence at all the locations (F = 66.16; d.f. = 7, 14; *p* = 0.00 at Jalandhar; F = 17.08; d.f. = 7, 14; p = 0.00 at Modipuram; F = 25.34; d.f. = 7, 14; p = 0.00 at Gwalior) (Table 1). Lowest incidence was recorded with fipronil 0.3G @ 25 kg/ ha which was on par with fipronil 0.3G @ 20 kg/ ha, cartap hydrochloride 4G @ 20 kg/ ha and cartap hydrochloride 4G @ 25 kg/ ha. The overall reduction over control ranged between 53.17 and 62.40% at the three locations.

Aphids (various species): Among the collected aphid samples, *Rhopalosiphum rifiabdominale* (Sasaki) (rice root aphid), *Aphis gossypii* Glover (cotton or melon aphid), *Aphis nasturtii* Kaltenbach (buckthorn-potato aphid), *Myzus persicae* (Sulzer) (peach-potato aphid) and *R. nymphaeae* (L.) (water lily aphid) were predominant. The effect of insecticide treatments was significant on the cumulative incidence of aphids (F = 41.20; d.f. = 7, 14; p = 0.00) at Jalandhar (Table 1). Among the treatments, fipronil 0.3G @ 25 kg/ ha performed best and was on par with fipronil 0.3G @ 20 kg/ ha, cartap hydrochloride 4G @ 20 kg/ ha and cartap hydrochloride 4G @ 25 kg/ ha. The cumulative reduction in the incidence over control ranged between 59.80 and 60.78% with these treatments.

Leaf hoppers: The effect of insecticide treatments was significant on the cumulative incidence (F = 25.83; d.f. = 7, 14; p = 0.00) at Modipuram (Table 1). Among the treatments, fipronil 0.3G @ 20 and 25 kg/ ha, and cartap hydrochloride 4G @ 20 and 25 kg/ ha performed best and were on par with each other. The reduction in incidence ranged between 58.60 and 65.94% with these treatments.

***Thrips palmi*:** The effect of insecticide treatments was significant on the cumulative number of thrips at Gwalior (F = 341.31; d.f. = 7, 14; p = 0.00) (Table 1). Among the treatments, fipronil 0.3G @ 20 and 25 kg/ ha, and cartap hydrochloride 4G @ 20 and 25 kg/ ha performed best and were on par with each other. The reduction over control ranged between 60.87 and 61.11% with these treatments. The effect of insecticides on the incidence of whiteflies, aphids, leafhoppers and thrips was significant from 5– 10 to 40 days after incorporation.

The granular formulations of cartap hydrochloride and fipronil have been found effective for the management of many sucking and chewing pests and are currently being used for pest management in many crops. Either or both the insecticides are reported to successfully reduce the incidence of stem borers and leaf folder and brown plant hoppers in rice (Lal, 2006; Dhaka et al., 2011; Abro et al., 2013; Kharbade et al., 2015; Sandhu and Dhaliwal, 2016; Guruprasath and Ayyasamy, 2019), onion thrips (Pathak et al., 2018) and sugarcane wooly aphids (Mane et al., 2016) to mention a few.

Yield and benefit cost analysis: The effect of treatments was non-significant for total tuber yield at all the locations however, insecticide treated plots recorded slightly higher yield as compared to untreated control. Among the four insecticide treatments that provided highest suppression in insect populations, highest cost benefit ratio was for cartap hydrochloride 4G @ 20 kg/ ha and fipronil 0.3G @ 20 kg/ ha (2.62 and 2.47, respectively (Table 2). Further, no phytotoxicity symptoms were associated with any of the insecticide treatments.

Therefore, it is concluded that the soil incorporation of cartap hydrochloride 4G @ 20 kg/ ha or fipronil 0.3G @ 20 kg/ ha at earthing-up in potato crops can be recommended for the management of sucking pests (aphids, whiteflies, leafhopers and thrips) in potato crops in place of phorate 10G.

Table 1. Efficacy of soil insecticides against *B. tabaci*, aphids, leafhoppers and thrips in potato

No.	Treatments	Jalandhar			Modipuram			Gwalior			Jalandhar			Modipuram			Gwalior		
		Pre-count	Mean post-count	% reduction	Pre-count	Mean post-count	% reduction	Pre-count	Mean post-count	% reduction	Pre-count	Mean post-count	% reduction	Pre-count	Mean post-count	% reduction	Pre-count	Mean post-count	% reduction
		B. tabaci									aphid			leafhopper			thrips		
1.	Cartap Hydrochloride 4 G @ 15 kg/ ha	15.00 (3.96)	5.83 (2.61)^{c}	42.78	3.67 (2.15)	3.11 (2.02)^{b}	34.27	13.50 (3.80)	6.58 (2.75)^{b}	39.52	5.00 (2.44)	3.56 (2.13)^{b}	37.25	7.33 (2.88)	3.72 (2.17)^{b}	34.33	18.67 (4.42)	10.44 (3.38)^{b}	43.04
2.	Cartap Hydrochloride 4 G @ 20 kg/ ha	14.00 (3.85)	4.11 (2.26)^{a}	56.84	3.33 (2.07)	2.00 (1.73)^{a}	53.17	13.33 (3.78)	4.50 (2.34)^{a}	58.13	5.00 (2.44)	2.28 (1.80)^{a}	59.80	7.33 (2.88)	2.22 (1.79)^{a}	60.41	18.67 (4.43)	7.17 (2.85)^{a}	60.87
3.	Cartap Hydrochloride 4 G @ 25 kg/ ha	16.00 (4.11)	4.44 (2.33)^{a}	59.04	3.67 (2.15)	1.89 (1.69)^{a}	59.90	12.67 (3.68)	4.17 (2.27)^{a}	59.24	5.00 (2.44)	2.28 (1.80)^{a}	59.80	7.67 (2.94)	2.17 (1.77)^{a}	63.06	18.33 (4.39)	7.00 (2.82)^{a}	61.11
4.	Fipronil 0.3 G @ 15 kg/ ha	14.33 (3.86)	5.44 (2.54)^{c}	44.06	3.00 (1.98)	3.00 (1.99)^{b}	22.75	13.67 (3.82)	6.50 (2.73)^{b}	40.97	4.67 (2.35)	3.44 (2.10)^{b}	34.87	7.00 (2.82)	3.56 (2.13)^{b}	33.99	19.33 (4.50)	10.19 (3.34)^{b}	46.33
5.	Fipronil 0.3 G @ 20 kg/ ha	15.33 (4.03)	4.50 (2.34)^{ab}	56.70	3.67 (2.15)	2.06 (1.74)^{a}	56.49	12.83 (3.71)	4.42 (2.32)^{a}	57.33	5.33 (2.50)	2.39 (1.84)^{a}	60.48	6.67 (2.76)	2.11 (1.76)^{a}	58.60	19.33 (4.50)	7.44 (2.90)^{a}	60.78
6.	Fipronil 0.3 G @ 25 kg/ ha	13.67 (3.82)	3.83 (2.19)^{a}	58.63	3.67 (2.15)	1.83 (1.68)^{a}	60.89	14.00 (3.86)	4.25 (2.28)^{a}	62.40	5.00 (2.44)	2.22 (1.79)^{a}	60.78	7.67 (2.94)	2.00 (1.73)^{a}	65.94	18.33 (4.38)	7.00 (2.82)^{a}	61.09
7.	Phorate 10 G @ 15 kg/ Ha	15.67 (4.06)	6.11 (2.66)^{c}	42.57	3.33 (2.06)	3.17 (2.04)^{b}	26.55	13.17 (3.76)	6.42 (2.72)^{b}	39.63	4.67 (2.37)	3.39 (2.09)^{b}	35.92	7.33 (2.88)	3.78 (2.18)^{b}	33.34	19.33 (4.50)	10.97 (3.45)^{b}	42.22
8.	Control	15.33 (3.98)	10.44 (3.38)^{d}	–	4.33 (2.30)	5.61 (2.57)^{c}	–	13.67 (3.82)	11.03 (3.46)^{c}	–	5.00 (2.44)	5.67 (2.58)^{c}	–	7.33 (2.88)	5.67 (2.58)^{c}	–	19.33 (4.50)	19.00 (4.47)^{c}	–
SEm		0.31	0.04		0.07	0.04		0.14	0.04		0.13		0.04	0.04	0.06		0.14	0.03	
CD (p = 0.05)		NA	0.14		NA	0.13		NA	0.13		NA		0.12	NA	0.18		NA	0.09	

Values from pooled data of two seasons; Pre-count- Pre-treatment count; Mean-post count- Cumulative mean of post-treatment counts, % reduction - % reduction over control; values in parentheses are square root transformed as √x+0.5, NA –Not applicable

Table 2. Benefit cost ratio of soil insecticides in potato

No.	Treatments	Jalandhar	Modipuram	Gwalior	Mean
1.	Cartap hydrochloride 4G @ 15 kg/ ha	1: 1.16	1: 1.38	1: 1.39	1: 1.31
2.	Cartap hydrochloride 4G @ 20 kg/ ha	1: 3.00	1: 2.95	1: 1.91	1: 2.62
3.	Cartap hydrochloride 4G @ 25 kg/ ha	1:2.62	1: 2.93	1: 1.92	1: 2.49
4.	Fipronil 0.3G @ 15 kg/ ha	1: 1.04	1: 1.47	1: 1.39	1: 1.30
5.	Fipronil 0.3G @ 20 kg/ ha	1: 2.60	1: 2.92	1: 1.90	1: 2.47
6.	Fipronil 0.3G @ 25 kg/ ha	1: 2.62	1: 2.94	1: 1.91	1: 2.49
7.	Phorate 10G @ 15 kg/ ha	1: 0.80	1: 1.32	1: 1.29	1: 1.14
8.	Control	-	-	-	-

Sale price of potato- Rs. 600/ q; cost for soil incorporation of insecticides- Rs. 650/ ha; cartap hydrochloride 4G- Rs. 112/ kg, fipronil 0.3G- Rs. 115/ kg; phorate 10G- Rs. 85/ kg

REFERENCES

Abro G H, Syed T S, Shah A H, Cui J, Sattar M, Awan M S. 2013. Efficacy and economics of different insecticides against stem borers, *Scirpophaga incertulas* (Walker) in rice crop. Pakistan Journal of Zoology 45(4): 929-933.

Bhatnagar A, Jandrajupalli S, Venkateswarlu V, Malik K, Shah M A, Singh B P. 2017. Mapping of aphid species associated with potato in India using morphological and molecular taxonomic approaches. Potato Journal 44(2): 126-134.

Bhatnagar A. 2007. Incidence and succession of thrips, leafhoppers and whitefly in combination of planting dates and potato varieties. Annals of Plants Protection Sciences 15(1): 101-105.

Bhatnagar A. 2008. Insect associated with potato in Madhya Pradesh. Pest Management in Horticultural Ecosystem 13(2): 21-24.

Dhaka S S, Prajapati C R, Singh D V, Singh R. 2011. Field evaluation of insecticides and bio-pesticides against rice leaf folder, *Cnaphalocrocis medinalis* (Guenee). Annals of Plant Protection Sciences 19(2): 324-326.

Guruprasath S, Ayyasamy R. 2019. Bioefficacy of newer formulation of fipronil 0.8 G against brown planthopper of rice, *Nilaparvata lugens* (Stal.). Journal of Entomological Research 43(3): 283-287.

Henderson C F, Tilton E W. 1955. Tests with acaricides against the brown wheat mite. Journal of Economic Entomology 48: 157-161.

Kharbade S B, Chormule A J, Tamboli N D. 2015. Bio-efficacy of granular insecticides against *Nilaparvata lugens* (Stal.) in rice under field condition. Annals of Plant Protection Sciences 23(2): 250-252.

Lal R. 2006. Effect of fipronil on the incidence of stem borers in basmati rice. Pesticide Research Journal 18(2): 146-149.

Mane M A, Mohite P B, Patil S A. 2016. Population dynamics and management of sugarcane woolly aphids, *Ceratovacuna lanigera* (Zehntner) (Hemiptera: Aphididae) with new molecules of insecticides. International Journal of Advanced Research 4(10): 2047-2050.

Nirula K K, Kumar B. 1969. Soil application of systemic insecticides for the control of aphid vectors, leaf roll and Y viruses in potato. Indian Journal of Agricultural Sciences 39: 699-702.

Nirula K K. 1962. Insecticidal control of the spread of leaf roll and virus Y in potatoes. Indian Potato Journal 4: 1-6.

Pathak M K, Pandey M K, Gupta R C, Gupta P K. 2018. Evaluation of different insecticides against onion thrips in onion seed production. International Journal of Current Microbiology and Applied Sciences 7(7): 4204-4207.

Rizvi S M A, Chandla V K, Bist B S. 1976. Evaluation of some systemic granular insecticides against *Myzus persicae* Sulzer on potatoes. Potato Research 19: 183-185.

Sandhu G S, Dhaliwal N S. 2016. Evaluation of different insecticides against major insect pests of rice in Punjab. International Journal of Plant Protection 9(1): 187-192.

Shah M A, Malik K, Bhatnagar A, Katare S, Sharma S, Chakrabarti S K. 2019. Effect of temperature and cropping sequence on the infestation pattern of *Bemisia tabaci* in potato. Indian Journal of Agricultural Sciences 89(11): 1802-7.

Simon-Delso N, Amaral-Rogers V, Belzunces L P, Bonmatin J M, Chagnon M, Downs C, Furlan L, Gibbons D W, Giorio C, Girolami V, Goulson D. 2015. Systemic insecticides (neonicotinoids and fipronil): trends, uses, mode of action and metabolites. Environmental Science and Pollution Research 22(1): 5-34.

(Manuscript Received: January, 2021; Revised: February, 2021;
Accepted: March, 2021; Online Published: July, 2021)
Online published (Preview) in www.entosocindia.org Ref. No. e21014