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Evaluation of insecticides against aphid, *Myzus persicae* in potato and their cost economics

KAVITA HEGDE*[1], C. M. KALLESHWARASWAMY[1] and VENKATARAVANAPPA[2]

[1]Department of Entomology, College of Agriculture, University of Agricultural and Horticultural Sciences (UAHS), Shivamogga-577201, Karnataka, India

[2]Division of Plant Pathology, ICAR-CHES, ICAR-IIHR, Chettalli, Karnataka, India

***E-mail:** kavitahegde10@gmail.com

ABSTRACT: Potato virus Y (PVY) is the most important viral disease, having the highest economic impact on potato production worldwide including India**.** Green peach aphid, *Myzus persicae* is considered as the most efficient, cosmopolitan and commonly abundant aphid vector for PVY. The present study was conducted to know the effect of different crop labelled insecticides on aphid population and virus spread. The results revealed that thiamethoxam 25 WG was superior in reducing aphid population (3.67) which was followed by imidacloprid 17.8 SL (4.47). DAC-ELISA recorded lower spread of PVY in thiamethoxam 25 WG and imidacloprid 17.8 SL treated plots. Overall, the study revealed that insecticides were efficient in reducing aphid population, which are the vectors of this virus, but could not completely limit the virus spread in the field.

Keywords: Aphids**,** imidacloprid, non-persistent, thiamethoxam, virus

INTRODUCTION

Potato virus Y (PVY, Genus; Potyvirus, Family; Potyviridae) is the most important viral disease, having the highest economic impact on potato production worldwide including India (Valkonen, 2007). It is a non-persistent virus, where no latent period occurs and insect vector remains viruliferous only for a few feeding probes following acquisition (Bradley and Ride out, 1953).Symptoms of PVY infection in potato are mosaic, crinkling, and necrosis of leaves; secondarily infected plants are stunted and have brittle foliage (de Bokx and Huttinga 1981).The virus may also cause post-harvest losses due to tuber ne-crosis and reduced storage quality. In India, green peach aphid, *Myzus persicae* (Sulz.) is considered as the most efficient, cosmopolitan and commonly abundant aphid vector for PVY in potato (Robert, 1971; Varma, 1988) and causes yield loss up to 85 per cent (Nagaich, 1975). PVY management in field during potato production implies the use of insecticide to control aphid vectors, since aphid transmission is the most important mode of virus transmission in a field during a growing season. Application of insecticide will seldom achieve any practical or permanent control of PVY. However, insecticides are integral part of the overall pest management program for most potato producers, and these compounds very likely do limit some secondary (plant-to-plant) spread of PVY by managing colonizing aphid species such as green peach aphid.

MATERIALS AND METHOD

A field experiment was carried out during *rabi* 2017-18 and *kharif* 2018 at Lingadahalli village ($13^{0}37'$ N latitude and 75^{0} 49' E longitudes with an altitude of 753 meters from MSL) of Chikkamagaluru district of Karnataka, India using popular variety 'Kufri Jyothi' in order to find out the efficacy of insecticides against potato aphids and the virus incidence. The field experiment was laid out in randomized block design (RBD) with three replications and eight treatments with 4 m x 4 m plot size. In each plot, five plants were selected and tagged. Sowing was done on 19th December in *rabi* 2017-18 and on 5th July in *kharif* 2018. The first spray was given on 22ndJanuary in *Rabi*2017 and 10th August in *kharif* 2018. Similarly, the second spray was given on 13th February-2018 in *Rabi* and 1stSeptember-2018 in *kharif*.

Observations were made on the number of aphids per leaf. Three fully expanded leaves from each tagged plant were examined (one each on the top, middle, and lower parts of the plant) in each replication. Aphid population was recorded a day before, seventh and fourteen days after application of insecticides. Yield data were recorded and computed on hectare basis. The cost: benefit ratio was calculated for both the seasons, *i.e. rabi* 2017-18 and *kharif* 2018.Observations on PVY were recorded based on visible symptoms in each treatment. Plants showing stunting, severe to wild mosaic, mottling and crinkling of leaves were considered as PVY affected plants. Further,

Table 1. Efficacy of insecticides against the aphid, *M. persicae,* a vector of PVY in potato during *rabi* 2017-18

Treatment	Mean number of aphids/three compound leaves				
		I spray		II spray	
	DBS	7DAS	14DAS	7DAS	14DAS
T1- Imidacloprid 17.8 SL @0.3ml	15.40 (3.98)	4.20 (2.15)[de]	4.33 (2.20)[de]	4.07 (2.13)[ef]	3.80 (2.07)[e]
T2- Acetamiprid 20 SP @0.3g	15.07 (3.93)	5.00 (2.33)[cde]	5.20 (2.39)[cde]	4.40 (2.21)[def]	4.67 (2.27)[cde]
T3- Acephate 75 SP @1.5g	16.93 (4.17)	5.27 (2.39)[cde]	5.33 (2.41)[bcde]	4.80 (2.30)[de]	5.33 (2.41)[cd]
T4- Thiamethoxam 25 WG @0.5g	15.47 (3.99)	3.40 (1.96)[e]	3.80 (2.07)[e]	3.47 (1.98)[f]	3.53 (2.01)[e]
T5- Dinotefuron 20 SG @0.3g	14.80 (3.91)	6.00 (2.55)[bcd]	6.33 (2.61)[bcd]	5.20 (2.39)[cd]	5.60 (2.47)[cd]
T6- Acephate 50% + Imidacloprid 1.8% SP @2g	12.60 (3.61)	4.53 (2.24)[cde]	5.53 (2.45)[bcde]	4.07 (2.13)[ef]	4.27 (2.15)[de]
T7- Dimethoate 30 EC @1.7ml	13.27 (3.70)	6.47 (2.64)[bc]	6.60 (2.66)[bc]	6.13 (2.57)[c]	6.33 (2.61)[c]
T8- NSKE 5%	13.00 (3.66)	8.40 (2.98)[b]	7.87 (2.85)[b]	7.93 (2.90)[b]	8.67 (3.03)[b]
T9- Untreated control	15.07 (3.94)	19.07 (4.42)[a]	18.53 (4.36)[a]	20.27 (4.55)[a]	19.87 (4.51)[a]
F value	NS	*	*	*	*
SEm±	0.18	0.15	0.15	0.09	0.12
CD (P=0.05)	0.55	0.44	0.45	0.26	0.35
CV %	8.13	9.72	9.67	5.80	7.67

Three compound leaves per plant; 5 tagged plants per replication
Numbers in the parenthesis are $\sqrt{X+0.5}$transformed values
NS-Non significant; * Significantat (P≤0.05); DBS-day before spray; DAS-day after spray

leaf samples were collected from each plant on 50th day in each treatment and next day DAC-ELISA was performed to confirm the viral infection. Obtained data were analysed using ANOVA.

Cost economics of various treatments used against aphids

Yield data were recorded and computed on a hectare basis. C: B ratio was calculated for both the seasons, *i.e.*, *Rabi* 2017-18 and *kharif* 2018.The cost of cultivation was worked out considering the input materials like seeds, fertilizers, plant protection chemicals and the labour input for all the operations. Treatment wise cost of cultivation was worked out with the prevailing price of input materials and labour and expressed in Rs./ha.

RESULTS AND DISCUSSION

Different insecticides were evaluated against aphids infesting potato in farmer's field at Lingadahalli, Chikkamagaluru during *Rabi* 2017-18 and *Kharif* 2018.

In *rabi* 2017-18, the pre-treatment population of the aphids per plant in all the treatments varied from 12.60 to 16.93 (Table1). The range of PVY incidence was 16.85 per cent to 27.72 before a day of spraying (Table 4). In first spray at seven days after treatment, the lowest aphid population per plant was recorded with the thiamethoxam 25 WG (3.40), followed by imidacloprid 17.8 SL (4.20). In untreated control, the aphid population was 19.07and significantly differed from other treatments (Table 1). Both visual and DAC-ELISA data recorded lower spread of virus in plots sprayed with thiamethoxam 25 WG and imidacloprid 17.8 SL (Table 4). At 14 days after treatment imposition, a similar trend was noticed. The lowest aphid population per plant was noticed in plots sprayed with thiamethoxam 25 WG (3.80), which was followed by imidacloprid 17.8 SL (4.33) (Table 1). DAC-ELISA proved that the spread was comparatively low in thiamethoxam 25 WG and imidacloprid 17.8 SL (Table 4). At second spray, the lowest aphid population per plant was recorded from the thiamethoxam 25 WG treated plot (3.47) at seven days after treatment imposition and was closely followed by imidacloprid 17.8 SL and Acephate 50% + imidacloprid 1.8% SP (4.07) (Table 1). There was no significant difference observed with respect to virus incidence among all the treatments compared to untreated control (Table 4).Observationsat14 days after treatment showed the lowest aphid population per plant in thiamethoxam 25 WG (3.53) and imidacloprid 17.8 SL (3.80) and did not show any statistical difference (Table 1). The virus spread was minimized in insecticide treated plots compared to untreated control (Table 4).

In *kharif* 2018, the pre-treatment population of the aphid a day before treatment varied from 13.27 to 17.87 (Table 2).The range of PVY incidence was 14.98 per cent to 25.09 per cent before a day of spraying (Table 5). After seven days of first sray, thiamethoxam 25 WG registered the lowest number of aphids per plant (3.93) and was proved to be the best treatment. In untreated control, the aphid population was 19.33 per plant and differed significantly compared to other treatments (Table 2). Both visual data and DAC-ELISA proved minimized spread of virus in insecticide treated plots compared to untreated control. Among insecticides, thiamethoxam 25 WG, imidacloprid 17.8 SL and acephate 50% + imidacloprid 1.8% SP proved their best in virus spread (Table 5). At 14DAT, thiamethoxam 25 WG (4.27) and imidacloprid 17.8 SL (4.67) were found to be significantly superior by recording a lower number of aphids per plant compared to rest of the treatments (Table 2). DAC-ELISA recorded lower spread in thiamethoxam 25 WG and imidacloprid 17.8 SL (Table 5).The observations recorded at 7 days after second spray indicated that thiamethoxam 25 WG was most effective in reducing aphid population which recorded 3 aphids/plant, and was followed by imidacloprid 17.8 SL and acetamiprid 20 SP (4.40)(Table 2). Both visual and DAC-ELISA data recorded lower spread of virus in insecticides sprayed plots compared to untreated control except plot sprayed with NSKE 5% (Table 5).After 14 days of second spray, the lowest aphid population per plant was recorded with the thiamethoxam 25 WG (3.47), which was followed by imidacloprid 17.8 SL (3.60)(Table 2). DAC-ELISA proved the lower spread in insecticide treated plots (Table 5).

In pooled data, the pre-treatment population of the aphid a day before in all the treatments varied from 13.13 to 16.93 (Table 3).The range of PVY incidence was 15.92 per cent to 25.47 per cent before a day of spraying (Table 6).The data recorded at 7 days after first spray revealed the significant differences among the treatments. Lowest aphid population per plant was recorded with the thiamethoxam 25 WG (3.67) which was followed by imidacloprid 17.8 SL (4.47) (Table 3). DAC-ELISA recorded lower spread in thiamethoxam 25 WG, imidacloprid 17.8 SL, dinotefuran 20 SG and acephate 50% + imidacloprid 1.8% SP treated plots than untreated control (Table 4).At14DAT, the results indicated that thiamethoxam 25 WG was found to be significantly superior by recording the lowest aphid population per plant (4.03) which was followed closely by imidacloprid 17.8 SL (4.50). DAC-ELISA proved the spread was comparatively low in thiamethoxam 25 WG, imidacloprid 17.8 SL and dinotefuran 20 SG (Table 4). During second spray, the number of aphids per plant recorded at 7 DAT, indicated that the lowest aphid

Table 2. Efficacy of insecticides against on the aphid, *M. persicae,* a vector of PVY in potato during *Kharif* 2018-19

Treatment	Mean number of aphids/three compound leaves				
		I spray		II spray	
	DBS	7DAS	14DAS	7DAS	14DAS
T1- Imidacloprid17.8 SL@0.3ml	16.40 (4.10)	4.73 (2.27)[cd]	4.67 (2.27)[de]	4.40 (2.21)[d]	3.60 (2.02)[e]
T2- Acetamiprid 20 SP@0.3g	17.87 (4.29)	5.53 (2.44)[cd]	5.20 (2.38)[cde]	4.40 (2.21)[d]	4.60 (2.26)[de]
T3- Acephate75 SP@1.5g	16.93 (4.17)	5.87 (2.52)[cd]	5.73 (2.49)[cde]	5.33 (2.41)[cd]	5.40 (2.42)[cd]
T4- Thiamethoxam 25 WG@0.5g	17.13 (4.19)	3.93 (2.09)[d]	4.27 (2.18)[e]	3.00 (1.87)[e]	3.47 (1.99)[e]
T5- Dinotefuron 20 SG@0.3g	15.93 (4.05)	6.60 (2.66)[bc]	6.47 (2.63)[c]	5.73 (2.49)[cd]	5.67 (2.48)[cd]
T6- Acephate 50% + Imidacloprid 1.8% SP@2g	13.73 (3.76)	5.13 (2.37)[cd]	6.07 (2.56)[cd]	5.20 (2.38)[cd]	4.33 (2.17)[de]
T7- Dimethoate 30 EC@1.7ml	14.73 (3.90)	6.67 (2.67)[bc]	6.93 (2.72)[c]	6.40 (2.62)[bc]	6.60 (2.66)[c]
T8- NSKE 5%	13.27 (3.70)	8.60 (3.01)[b]	9.40 (3.14)[b]	7.67 (2.86)[b]	9.13 (3.10)[b]
T9-Untreated control	16.33 (4.10)	19.33 (4.45)[a]	19.00 (4.41)[a]	18.60 (4.35)[a]	20.27 (4.55)[a]
F value	NS	*	*	*	*
SEm±	0.15	0.15	0.12	0.11	0.12
CD (P=0.05)	0.44	0.44	0.35	0.34	0.35
CV %	6.26	9.41	7.39	7.48	7.74

Three compound leaves per plant; 5 tagged plants per replication
Numbers in the parenthesis are $\sqrt{X+0.5}$transformed values
NS-Non significant; * Significantat ($P \leq 0.05$); DBS-day before spray; DAS-day after spray

Table 3. Efficacy of insecticides against on the aphid, *M. persicae,* a vector of PVY in potato (pooled)

Treatment	Mean number of aphids/three compound leaves				
		I spray		II spray	
	DBS	7DAS	14DAS	7DAS	14DAS
T1- Imidacloprid17.8 SL@0.3ml	15.90 (4.04)	4.47 (2.21)de	4.50 (2.23)de	4.23 (2.17)e	3.70 (2.05)e
T2- Acetamiprid 20 SP@0.3g	16.47 (4.12)	5.27 (2.38)cde	5.20 (2.39) cde	4.40 (2.21)e	4.63 (2.26)de
T3- Acephate75 SP@1.5g	16.93 (4.17)	5.57 (2.46)cde	5.53e (2.45) cde	5.07 (2.36)de	5.37 (2.42)cd
T4- Thiamethoxam 25 WG@0.5g	16.30 (4.09)	3.67 (2.03)e	4.03 (2.13)e	3.23 (1.93)f	3.50 (2.00)e
T5- Dinotefuron 20 SG@0.3g	15.37 (3.98)	6.30 (2.60)bcd	6.40 (2.62)c	5.47 (2.44)cd	5.63 (2.48)cd
T6- Acephate 50% + Imidacloprid 1.8% SP@2g	13.17 (3.69)	4.83 (2.31)cde	5.80 (2.50)cd	4.63 (2.26)de	4.30 (2.16)de
T7- Dimethoate 30 EC@1.7ml	14.00 (3.80)	6.57 (2.66)bc	6.77 (2.69)bc	6.27 (2.60)c	6.47 (2.64)c
T8- NSKE 5%	13.13 (3.68)	8.50 (2.99)b	8.63 (3.00)b	7.80 (2.88)b	8.90 (3.06)b
T9-Untreated control	15.70 (4.02)	19.20 (4.43)a	18.77 (4.39)a	19.43 (4.45)a	20.07 (4.53)a
F value	NS	*	*	*	*
SEm±	0.16	0.15	0.13	0.08	0.12
CD (P=0.05)	0.47	0.44	0.38	0.23	0.35
CV %	6.89	9.49	8.15	5.06	7.62

Three compound leaves per plant; 5 tagged plants per replication

Numbers in the parenthesis are √X+0.5transformed values

NS-Non significant; * Significantat (P≤0.05); DBS-day before spray; DAS-day after spray

Table 4. PVY incidence in different insecticides treated plots of potato (pooled)

Treatment	Virus incidence (%)									
			I spray				II spray			
	DBS		7 DAS		14 DAS		7 DAS		14 DAS	
	Visual	ELISA	Visual	ELISA	Visual	ELISA	Visual	ELISA	Visual	ELISA
T1- Imidacloprid17.8 SL@0.3ml	15.33	24.72 (29.81)	18.17	26.59 (31.04)	18.00	27.53 (31.65)	18.83	27.90 (31.89)	18.67	29.40 (32.84)
T2- Acetamiprid 20 SP@0.3g	9.00	15.92 (23.51)	14.17	20.79 (27.12)	16.50	24.91 (29.94)	17.83	28.09 (32.01)	17.50	31.65 (34.23)
T3- Acephate75 SP@1.5g	12.50	18.73 (25.64)	17.17	23.22 (28.81)	18.83	29.78 (33.07)	21.67	31.84 (34.35)	21.67	34.08 (35.72)
T4- Thiamethoxam 25 WG@0.5g	10.33	16.48 (23.95)	9.67	17.79 (24.95)	11.00	19.48 (26.19)	12.33	20.22 (26.73)	12.17	20.60 (26.99)
T5- Dinotefuron 20 SG@0.3g	18.33	24.34 (29.56)	22.17	30.15 (33.30)	24.50	31.65 (34.23)	26.17	35.39 (36.51)	27.50	37.83 (37.96)
T6- Acephate 50% + Imidacloprid 1.8% SP@2g	16.67	24.34 (29.56)	20.50	26.97 (31.28)	25.17	30.15 (33.30)	25.67	31.65 (34.23)	27.33	34.46 (35.94)
T7- Dimethoate 30 EC@1.7ml	10.33	18.91 (25.78)	17.67	25.09 (30.06)	22.00	29.59 (32.95)	23.33	31.46 (34.12)	25.33	32.58 (34.81)
T8- NSKE 5%	23.33	25.47 (30.31)	26.00	31.09 (33.89)	30.00	35.58 (36.62)	33.33	40.26 (39.38)	35.33	43.07 (41.02)
T9-Untreated control	19.00	20.97 (27.26)	27.83	30.34 (33.42)	34.17	36.14 (36.95)	37.83	41.01 (39.82)	41.67	44.38 (41.77)
F value		NS		NS		NS		NS		NS
SEm±		3.82		2.57		2.39		2.85		2.71
CD (P= 0.05)		11.45		7.71		7.17		8.54		8.13
CV %		24.60		14.71		12.69		14.42		13.20

NS-Non significant; Numbers in the parenthesis indicate the arcsine transformed value; DBS-day before spray; DAS-day after spray population per plant (3.23) was present in thiamethoxam 25 WG treated plots. Imidacloprid 17.8 SL was equally effective and recorded 4.23 aphids per plant followed byacetamiprid 20 SP (4.40) . Both visual and DAC-ELISA data recorded lower spread of virus in insecticides sprayed plots compared to untreated control except plot sprayed with NSKE 5%. After 14 days of treatment imposition, the lowest aphid population per plant was recorded with the thiamethoxam 25 WG (3.50), which was followed by imidacloprid 17.8 SL (3.70) (Table 3). DAC-ELISA proved the lower spread in insecticide treated plots (Table 4).

Yield and cost economics

Pooled data revealed that thiamethoxam 25 WG was superior among all the treatments by recording the highest yield of 20.58 t/ha. Next best treatments were imidacloprid 17.8 SL (18.15 t/ha), acephate 50% + imidacloprid 1.8% SP (16.91t/ha), acetamiprid 20 SP (16.19 t/ha), acephate 75 SP (15.54 t/ha) and dinotefuran 20 SG (15.34t/ha). However, lower yields were recorded with indimethoate 30 EC (14.29t/ha), NSKE 5% (12.20t/ha) and untreated control (11.04t/ha) and were inferior among the various treatments. Thiamethoxam 25 WG recorded highest B:C ratio (4.56) being superior to all other treatments, followed by imidacloprid 17.8 SL (4.11), acephate 50% + imidacloprid 1.8% SP (3.74), acetamiprid 20 SP (3.66), acephate 75 SP (3.50) and dinotefuran 20 SG (1:3.35). While, dimethoate 30 EC, NSKE 5% and untreated control recorded lower B:C ratio of 3.27and 2.75 and 2.58, respectively being inferior to rest of the treatments (Table 5).

It was evident from the above findings that the treatments had a differential effect in reducing aphid population at different intervals after the application when compared to untreated control. Thiamethoxam 25 WG was found to be the best for reducing the aphid

Table 5. Effect of selected insecticides on yield and cost economics of potato (pooled)

Treatment	Yield (t/ha)	Gross Income (Rs./ha)	Net Income (Rs./ha)	B:C
T1- Imidacloprid17.8 SL@0.3ml	18.15[b]	254129.17	192293.17	4.11
T2- Acetamiprid 20 SP@0.3g	16.19[bcd]	226625.00	164695.00	3.66
T3- Acephate75 SP@1.5g	15.54[cd]	217583.33	155401.33	3.50
T4- Thiamethoxam 25 WG@0.5g	20.58[a]	288166.67	224976.67	4.56
T5- Dinotefuron 20 SG@0.3g	15.34[cd]	214754.18	150650.17	3.35
T6- Acephate 50% + Imidacloprid 1.8% SP@2g	16.91[bc]	236716.67	173466.67	3.74
T7- Dimethoate 30 EC@1.7ml	14.29[de]	199995.83	138859.83	3.27
T8- NSKE 5%	12.20[ef]	170858.33	108808.33	2.75
T9-Untreated control	11.04[f]	154612.50	94762.50	2.58

population and was followed by imidacloprid 17.8 SL which was also equally effective. Other treatments also recorded moderate population reduction and differed statistically with untreated control. However, NSKE 5% was found to be least effective among the treatments. The present results on the effectiveness of thiamethoxam and imidacloprid in reducing the aphids are in accordance with the previous studies (Kumar *et al.,* 2016; Syed *et al.,* 2005) whore ported the lowest mean aphid population per leaf in thiamethoxam followed by imidacloprid. The similar results were found with the work of Sannino (1997) noticed the high performance of imidacloprid against *M. persicae* and Link *et al.* (2000) also reported the efficiency of imidacloprid against this pest. Wyman (2005) recorded that imidacloprid and thiamethoxam were equally effective against aphids in potato. The similar results were obtained by Khan (2011) and Patil and Lingappa (2000) who proved that imidacloprid was highly effective against *M. persicae* than acephate on tobacco.

Insecticides used in this study reduced the aphid population but failed to reduce PVY incidence. However, insecticides were effective to some extent in reducing the secondary spread of PVY. As tubers were primarily infected by PVY, insecticides could prevent only the secondary spread. In the experiment, thiamethoxam 25 WG and imidacloprid 17.8 SL proved their best in both the seasons. Findings of Kumar *et al*. (2016) are in agreement with our study by revealing the effectiveness of thiamethoxam in reducing secondary spread of PVY. Suranyi *et al*. (1998) proved the prevention of further spread of potato viruses with registered insecticides. Several studies tested the effects of the pyrethroid lambda-cyhalothrin and flonicamid insecticides having rapid incapacitation or antifeedant effects that would limit the ability of aphids to transmit the virus to other plants (Gibson *et al*., 1982; Morita *et al*., 2007; Boquel *et al*., 2015). Imidacloprid provided approximately 60 to 90 days of aphid protection but had no effect on reducing PVY spread (Boiteau and Singh, 1999).

CONCLUSION

Management of virus vectors is possible through insecticides but they never be entirely effective to reduce the spread of virus in the field as the tubers were primarily infected by those viruses. In addition to vector management, use of certified seed tubers, plays a big role in preventing virus spread from seed, which would then be transmitted by aphids from infected plants to other healthy plants. Early detection of the virus is very important as this will help the farmer to adopt effective control measures at early stages like removal of virus-infected plant, removal of weeds and application of systemic insecticides which will control the insect vector and check further spread of the disease.

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