Int.J.Curr.Microbiol.App.Sci (2017) *6*(7): 309-317

International Journal of Current Microbiology and Applied Sciences
ISSN: 2319-7706 **Volume 6 Number 7 (2017) pp. 309-317**
Journal homepage: http://www.ijcmas.com

Original Research Article https://doi.org/10.20546/ijcmas.2017.607.036

Bioefficacy of Cyantraniliprole 10% OD W/V (HGW86 10 OD) against Pests of Potato

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Keywords

Cyantraniliprole 10% OD, Aphid, Thrips, *H. armigera*, Potato.

Article Info

Accepted:
04 June 2017
Available Online:
10 July 2017

A B S T R A C T

A field experiment was conducted to evaluate the bio-efficacy of cyantraniliprole 10% OD against major insect pests infesting potato, *Solanum tuberosum* L. during *rabi* season of 2014 and 2015at Main Vegetable Research Station, Anand Agricultural University, Anand (Gujarat). During the course of study, three insect pest species, *viz.*, aphid (*Aphis gossypii* Glover), thrips (*Thrips tabaci* Lindeman) and *Helicoverpa armigera* Hübner (Hardwick) were recorded on potato at various stages of the crop. The tested insecticide cyantraniliprole 10% OD was evaluated at four doses *i.e.* 45, 60, 75 and 90 g a.i./ha along with dimethoate 30 EC at 200 g a.i./ha and thiamethoxam 25 WG at 25 g a.i./ha. The treatment of cyantraniliprole 10% OD @ 60 g a.i./ha found effective as it provided excellent protection against aphid, thrips and *H. armigera* in potato. This treatment also manifested higher tuber yield and found safer to spider observed in the field.

Introduction

Potato (*Solanum tuberosum* L.) is the fourth most important food crop in the world after wheat, rice, and maize in terms of production. It contributes about 22% of the total vegetables and about 40% of the root and tuber crops produced in the world (FAO, 2001). India is the third largest producer of potato crop in the world and it is grown in a commercial scale (Khurana and Naik, 2003). The main constraint to potato farming in India is vulnerable to pests and diseases hence implying a high risk of failure, growing potatoes requires substantial capital and the crop needs intensive care and attention.Potatoes are reported to be attacked by more than 80 insects and many nematode pests in the field and in store in India (Misra and Agrawal, 2008). They can be broadly classified into soil pests, sucking pests and sap feeders, defoliators and storage pests *viz.*, leaf eating caterpillar, serpentine leaf miner, *Helicoverpa armigera*, aphid, thrips, jassids and whitefly. Due to severe infestation of these pests, farmers fail to get higher yield even after frequent spray application of routine insecticides.Keeping in mind with these objectives, the bio-efficacy of cyantraniliprole was undertaken with recommended insecticides for the control of insect pests of potato. Scanty information is available of in efficacy on insect pests infesting potato. However, field bio-efficacy with different doses of cyantraniliprole was evaluated earlier by few workers (Patel *et al.*, 2011; Mandal, 2012; Misra, 2012; Patel and Kher, 2012a and Patel and Kher, 2012b) on other crops.

Cyantraniliprole (IRAC MoA 28) is a second generation anthranilic diamide insecticide discovered by DuPont Crop Protection. It has unique mode of action targeting the ryanodinereceptors (RyR) in insect muscle cells (Sattelle *et al.,* 2008; IRAC, 2012). Cyantraniliprole is the first to control a cross spectrum of chewing (Lepidoptera) and sucking (Hemiptera) pests (Anonymous, 2012). This group of insecticides also possesses the antifeedant properties (Gonzales-Coloma *et al.,* 1999).

Materials and Methods

A field experiment was conducted during *rabi* season of 2014 and 2015 to assess efficacy of cyantraniliprole 10% OD against insect pests ofpotato in a Randomized Block Design (RBD) at Main Vegetable Research Station, Anand Agricultural University, Anand (Gujarat). For the purpose, potato variety Kufri Pukhraj was planted in a plot of 4.5 x 3.0 m with a spacing of 45 x 15 cm. There were total four different doses of cyantraniliprole 10% OD tested and they are45, 60, 75 and 90 g a.i./ha along with check treatments dimethoate 30 EC at 200 g a.i./ha and thiamethoxam 25 WG at 25 g a.i./ha. The respective treatments of insecticides were sprayed on potato crop by manually operated knapsack sprayer with hollow cone nozzle. Considering the activity of different pests, two sprays were given during the crop period.

For sucking pest count (aphid and thrips), five plants were randomly selected and tagged in each net plot and recorded during early morning hrs. Population of aphid and thrips were recorded from 3 leaves (upper, middle, lower) per plant prior and after 3, 7 and 10 days of each spray. The data obtained were analyzed periodically, spray-wise as well as pooled over periods and sprays. The larval population of *H. armigera*, five plants were randomly selected and tagged in each net plot. Population of *H. armigera* larvae were recorded from the selected plants prior and after 3, 7 and 10 days of each spray. The data obtained were analyzed periodically, spray-wise as well as pooled over periods and sprays. In case of natural enemies, population was recorded before and after 3, 7 and 10 days of each spray from five randomly selected plants. The data of insect population were subjected to square root transformation for analysis.

Results and Discussion

Aphid

The data on pooled over periods and sprays on number of aphids per three leaves during first year are presented in Table 1. The data revealed among the different doses of cyantraniliprole 10% OD, the highest dose *i.e.* 90 g a.i./ha registered the lowest (1.16/ 3 leaves) aphid population than rest of the treatments, however, it remained at par with later two doses 75 and 60 g a.i./ha, which harboured the pest population of 1.24 and 1.32 per 3 leaves, respectively. The lowest dose (45 g a.i./ha) of cyantraniliprole 10% OD (2.74/ 3 leaves) was statistically inferior to its higher rates and remained at par with thiamethoxam 25 WG (2.67/ 3 leaves) but superior to dimethoate 30 EC (4.70/ 3 leaves).

During second year, the data on pooled over periods and sprays showed significant effectiveness of all the insecticidal treatments when compared with control. The highest dose 90 g a.i./ha of cyantraniliprole 10% OD found significantly effective in reducing aphid population (0.78 aphids/ 3 leaves) than rest of the treatments except 60 and 75 g a.i./ha of cyantraniliprole 10% OD with 0.80 and 0.82 aphids per 3 leaves, respectively and it was followed by thiamethoxam 25 WG (2.26 aphids/ 3 leaves) and the lowest dose of cyantraniliprole 10% OD @ 45 g a.i./ha (2.29 aphids/ 3 leaves).

Based on pooled results of both the years on bio-efficacy of cyantraniliprole 10% OD against aphid indicated that the plots treated with cyantraniliprole 10% OD @ 60, 75 and 90 g a.i./ha were significantly effective in controlling aphids in potato over rest of the treatments and these three treatments were at par with each other. The superiority of cyantraniliprole against *A. gossypii* revealed in present study is in accordance with the report of Mandal (2012) who reported that cyantraniliprole @ 90 and 105 g a.i./ha was more effective in reducing the pest population in tomato.

Thrips

The pooled result of two sprays during first year on thrips population (Table 2) recorded in different treatments indicated that the plots treated with cyantraniliprole 10% OD provided superior protection against thrips compared to standard checks and untreated control. Among the various doses of cyantraniliprole 10% OD, the higher three doses (90, 75 and 60 g a.i./ha) depicted the pest population between 0.48 and 0.69 thrips per three leaves and observed as significantly superior to its lower dose of 45 g a.i./ha, thiamethoxam 25 WG and dimethoate 30 EC (1.43, 1.60 and 2.81 per three leaves, respectively).

The result of two sprays on thrips population during second year illustrated that plots treated with cyantraniliprole 10% OD showed its superiority in suppressing thrips population over rest of the treatments. Plots treated with the highest dose of cyantraniliprole 10% OD @ 90 g a.i./ha recorded the lowest (0.69 thrips/ 3 leaves) and it was at par with its subsequent two doses *i.e.* 60 and 75 g a.i./ha (0.85 thrips/ 3 leaves). While, the remaining treatments of thiamethoxam 25 WG and cyantraniliprole 10% OD @ 45 g a.i./ha remained at par with each other and recorded higher (1.63 and 1.81) number of thrips population per three leaves than former treatments.

The pooled data of two years on bio-efficacy of cyantraniliprole 10% OD against thrips indicated that the plots treated with cyantraniliprole 10% OD @ 60, 75 and 90 g a.i./ha were significantly effective in controlling thrips in potato over rest of the treatments and these three treatments were at par with each other. On the other hand, treatment of dimethoate 30 EC (3.03 thrips/ 3 leaves) proved least effective with higher number of thrips than the lowest dose of cyantraniliprole 10% OD @ 45 g a.i./ha and thiamethoxam 25 WG (1.60 thrips/ 3 leaves).

Patel *et al.,* (2014) reported that two higher doses of cyantraniliprole 10% OD *i.e.* 90 and 105 g a.i./ha wasfound highly effective in managing the population of aphid, thrips and whitefly in cotton. According to Misra (2012), both the doses of cyantraniliprole *i.e.* 105 and 90 g a.i./ha were found equally effective against *T. tabaci* infesting tomato. This is in agreement with the present finding.

H. armigera

The larval population of *H. armigera* (Table 3) was significantly lower in all treated plots over control as it evident from the observations recorded during 1st year. The data on pooled over periods and sprays showed that the plots treated with cyantraniliprole 10% OD @ 90 g a.i./ha proved effective and recorded the lowest (0.67 larvae/ plant) number of larvae than remaining treatments. However, treatment of cyantraniliprole 10% OD @ 75 and 60 g a.i./ha registered lower (0.78 and 0.82 larvae/ plant) number of larvae and remained at par with the highest dose of cyantraniliprole 10% OD and it was followed by the lowest dose of cyantraniliprole 10% OD @ 45 g a.i./ha (1.87 larvae/ plant). Whereas, treatment of dimethoate 30 EC (3.54 larvae/ plant) and thiamethoxam 25 WG (3.62 larvae/ plant) remained at par with each other and proved less effective in suppressing the pest.

Table.1 Effect of different insecticides against aphid in potato (Pooled over years)

Treatments (g a.i./ha)	Number of aphid/ 3 leaves					
	2014		2015		Pooled	
Cyantraniliprole 10 OD (45)	1.80b* (2.74)		1.67b (2.29)		1.73b (2.49)	
Cyantraniliprole 10 OD (60)	1.35a (1.32)		1.14a (0.80)		1.24a (1.04)	
Cyantraniliprole 10 OD (75)	1.32a (1.24)		1.15a (0.82)		1.24a (1.04)	
Cyantraniliprole 10 OD (90)	1.29a (1.16)		1.13a (0.78)		1.21a (0.96)	
Thiamethoxam 25 WG (25)	1.78b (2.67)		1.66b (2.26)		1.72b (2.46)	
Dimethoate 30 EC (200)	2.28c (4.70)		2.16c (4.17)		2.22c (4.43)	
Untreated Control	2.79d (7.28)		2.74d (7.01)		2.76d (7.12)	
	S. Em. ±	**CD (5%)**	**S. Em. ±**	**CD (5%)**	**S. Em. ±**	**CD (5%)**
Treatment (T)	0.04	0.12	0.04	0.12	0.03	0.08
Period (P)	0.03	0.08	0.03	0.07	0.08	NS
Spray (S)	0.02	0.06	0.02	NS	0.02	0.04
Year (Y)	-	-	-	-	0.02	0.04
T x P	0.06	0.16	0.06	NS	0.05	NS
T x S	0.04	NS	0.04	NS	0.04	NS
T x Y	-	-	-	-	0.04	NS
P x S	0.07	NS	0.07	0.20	0.06	NS
P x Y	-	NS	-	-	0.03	NS
S x Y	-	-	-	-	0.03	NS
T x P x S	0.10	NS	0.10	NS	0.07	0.19
T x P x Y	-	-	-	-	0.07	NS
T x S x Y	-	-	-	-	0.06	NS
P x S x Y	-	-	-	-	0.04	0.10
T x P x S x Y	-	-	-	-	0.10	NS
C. V. %	9.60		10.19		9.82	

* Figures in parentheses are retransformed values; those outside are $\sqrt{X+0.5}$ transformed values; NS = Not significant

Table.2 Effect of different insecticides against thrips in potato (Pooled over years)

Treatments (g a.i./ha)	Number of thrips/ 3 leaves					
	2014		2015		Pooled	
Cyantraniliprole 10 OD (45)	1.39b* (1.43)		1.52b (1.81)		1.45b (1.60)	
Cyantraniliprole 10 OD (60)	1.09a (0.69)		1.16a (0.85)		1.13a (0.78)	
Cyantraniliprole 10 OD (75)	1.06a (0.62)		1.16a (0.85)		1.11a (0.73)	
Cyantraniliprole 10 OD (90)	0.99a (0.48)		1.09a (0.69)		1.04a (0.58)	
Thiamethoxam 25 WG (25)	1.45b (1.60)		1.46b (1.63)		1.45b (1.60)	
Dimethoate 30 EC (200)	1.82c (2.81)		1.95c (3.30)		1.88c (3.03)	
Untreated Control	2.36d (5.07)		2.90d (7.91)		2.63d (6.42)	
	S. Em. ±	**CD (5%)**	**S. Em. ±**	**CD (5%)**	**S. Em. ±**	**CD (5%)**
Treatment (T)	0.04	0.13	0.04	0.11	0.09	0.30
Period (P)	0.03	0.07	0.02	0.07	0.04	NS
Spray (S)	0.02	NS	0.02	NS	0.002	NS
Year (Y)	-	-	-	-	0.02	0.04
T x P	0.06	0.16	0.05	NS	0.05	0.13
T x S	0.04	0.10	0.03	NS	0.04	0.10
T x Y	-	-	-	-	0.04	0.11
P x S	0.07	0.19	0.06	0.17	0.07	NS
P x Y	-	-	-	-	0.02	0.07
S x Y	-	-	-	-	0.02	0.07
T x P x S	0.10	0.27	0.09	0.25	0.07	0.18
T x P x Y	-	-	-	-	0.07	NS
T x S x Y	-	-	-	-	0.05	NS
P x S x Y	-	-	-	-	0.04	0.10
T x P x S x Y	-	-	-	-	0.09	NS
C. V. %	11.37		9.43		10.38	

* Figures in parentheses are retransformed values; those outside are $\sqrt{x+0.5}$ transformed values; NS = Not significant

Table.3 Effect of different insecticides against larval population of *H. armigera* in potato (Pooled over years)

Treatments (g a.i./ha)	Number of larvae/ plant					
	2014		2015		Pooled	
Cyantraniliprole 10 OD (45)	1.54b* (1.87)		1.39b (1.43)		1.47b (1.66)	
Cyantraniliprole 10 OD (60)	1.15a (0.82)		1.07a (0.64)		1.11a (0.73)	
Cyantraniliprole 10 OD (75)	1.13a (0.78)		1.05a (0.60)		1.09a (0.69)	
Cyantraniliprole 10 OD (90)	1.08a (0.67)		1.00a (0.51)		1.04a (0.58)	
Thiamethoxam 25 WG (25)	2.03c (3.62)		1.84c (2.89)		1.93c (3.22)	
Dimethoate 30 EC (200)	2.01c (3.54)		1.92c (3.19)		1.97c (3.38)	
Untreated Control	2.41d (5.31)		2.12d (3.99)		2.27d (4.65)	
	S. Em. ±	**CD (5%)**	**S. Em. ±**	**CD (5%)**	**S. Em. ±**	**CD (5%)**
Treatment (T)	0.04	0.13	0.03	0.08	0.04	0.14
Period (P)	0.02	NS	0.02	NS	0.04	0.13
Spray (S)	0.02	NS	0.02	0.06	0.01	NS
Year (Y)	-	-	-	-	0.01	0.04
T x P	0.05	NS	0.05	NS	0.05	0.13
T x S	0.03	NS	0.03	NS	0.04	NS
T x Y	-	-	-	-	0.04	0.10
P x S	0.06	NS	0.07	NS	0.02	NS
P x Y	-	-	-	-	0.02	NS
S x Y	-	-	-	-	0.03	NS
T x P x S	0.09	NS	0.09	NS	0.06	NS
T x P x Y	-	-	-	-	0.06	NS
T x S x Y	-	-	-	-	0.06	NS
P x S x Y	-	-	-	-	0.03	NS
T x P x S x Y	-	-	-	-	0.09	NS
C. V. %	9.40		10.80		9.99	

* Figures in parentheses are retransformed values; those outside are $\sqrt{X+0.5}$ transformed values; NS = Not significant

Table.4 Impact of different insecticides on spiders in potato (Pooled over years)

Treatments (g a.i./ha)	Number of spiders/ plant					
	2014		2015		Pooled	
Cyantraniliprole 10 OD (45)	1.07* (0.64)		1.15 (0.82)		1.11 (0.73)	
Cyantraniliprole 10 OD (60)	1.07 (0.64)		1.18 (0.89)		1.12 (0.75)	
Cyantraniliprole 10 OD (75)	1.09 (0.69)		1.13 (0.78)		1.11 (0.73)	
Cyantraniliprole 10 OD (90)	1.01 (0.52)		1.08 (0.67)		1.05 (0.60)	
Thiamethoxam 25 WG (25)	1.00 (0.50)		1.11 (0.73)		1.06 (0.62)	
Dimethoate 30 EC (200)	1.02 (0.54)		1.10 (0.71)		1.06 (0.62)	
Untreated Control	1.09 (1.69)		1.20 (0.94)		1.15 (0.82)	
	S. Em. ±	**CD (5%)**	**S. Em. ±**	**CD (5%)**	**S. Em. ±**	**CD (5%)**
Treatment (T)	0.05	NS	0.03	NS	0.03	NS
Period (P)	0.01	NS	0.02	NS	0.01	0.03
Spray (S)	0.01	NS	0.02	NS	0.01	NS
Year (Y)	-	-	-	-	0.01	0.04
T x P	0.03	NS	0.05	NS	0.03	NS
T x S	0.02	NS	0.03	NS	0.03	NS
T x Y	-	-	-	-	0.04	NS
P x S	0.03	NS	0.06	NS	0.04	NS
P x Y	-	-	-	-	0.02	NS
S x Y	-	-	-	-	0.02	NS
T x P x S	0.05	NS	0.08	NS	0.05	NS
T x P x Y	-	-	-	-	0.05	NS
T x S x Y	-	-	-	-	0.04	NS
P x S x Y	-	-	-	-	0.02	NS
T x P x S x Y	-	-	-	-	0.07	NS
C. V. %	7.85		11.91		10.25	

* Figures in parentheses are retransformed values; those outside are $\sqrt{X+0.5}$ transformed values; NS = Not significant

Table.5 Effect of different insecticides on yield of potato (Pooled over years)

Treatments (g a.i./ha)	Yield (t/ha)		
	2014	**2015**	**Pooled**
Cyantraniliprole 10 OD (45)	17.95b	19.07b	18.51b
Cyantraniliprole 10 OD (60)	24.80a	24.38a	24.59a
Cyantraniliprole 10 OD (75)	25.08a	24.83a	24.96a
Cyantraniliprole 10 OD (90)	25.58a	26.25a	25.92a
Thiamethoxam 25 WG (25)	18.10b	19.03b	18.57b
Dimethoate 30 EC (200)	12.60c	13.93c	13.27c
Untreated Control	5.53d	7.42d	6.48d
S. Em.± T	1.18	1.18	0.77
Y	-	-	0.45
T x Y	-	-	1.18
C. D. at 5% T	3.64	3.62	2.22
Y	-	-	1.38
T x Y	-	-	NS
C.V. (%)	11.06	10.57	10.81

The data on pooled over periods and sprays of second year indicated that among the different doses of cyantraniliprole 10% OD evaluated, the plots treated with 90 g a.i./ha registered the least (0.51 larvae/ plant) population of larvae. However, treatment of cyantraniliprole 10% OD @ 75 and 60 g a.i./ha (0.60 and 0.64 larvae/ plant) remained at par with the highest dose, but found statistically superior to the lowest dose of cyantraniliprole 10% OD @ 45 g a.i./ha (1.43 larvae/ plant).

The data on pooled over years indicated that treatment of cyantraniliprole 10% OD @ 90 g a.i./ha registered significantly the least (0.58 larvae/ plant) number of larvae than the rest of treatments except cyantraniliprole 10% OD @ 75 and 60 g a.i./ha (0.69 and 0.73 larvae/ plant) with which it remained at par. However, treatment of cyantraniliprole 10% OD @ 45 g a.i./ha recorded significantly lower (1.66 larvae/ plant) number of larvae than thiamethoxam 25 WG (3.22 larvae/ plant), dimethoate 30 EC (3.38 larvae/ plant) and untreated control (4.65 larvae/ plant).The results are in agreement with the findings of Mandal (2012) reported the higher effectiveness of cyantraniliprole @ 90 and 105 g a.i./ha against the fruit borer, *H. armigera* in tomato.

Natural Enemies

The population of natural enemies prevailing in potato ecosystem was very low. Population of *Chrysoperla* and coccinellids was not found in potato crop even in the control plots, but population of spiders was observed during both the seasons (Table 4).There was no significant impact of any of the insecticidal treatments after its application as the result was non-significant. Data clearly revealed that all the insecticidal treatments including all the four different doses of cyantraniliprole 10% OD found more or less equally safer to the population of spiders. Shah *et al.,* (2012) reported the safety of anthranilic diamide group of insecticide chlorantraniliprole to spider, which corroborates the present findings. In a nutshell, cyantraniliprole 10 OD was found safe to spider at all the tested doses and hence can easily be incorporated in an Integrated Pest Management programme.

Yield

The data on yield (Table 5) revealed that all the insecticidal treatments produced significantly higher potato tubers when compared with control during first and second year as well as in pooled. Among the different treatments, cyantraniliprole 10% OD @ 90 g a.i./ha recorded significantly the highest yield of potato (25.58 t/ha) than the rest of treatments except cyantraniliprole 10% OD @ 75 and 60 g a.i./ha (25.08 and 24.80 t/ha) with which it remained at par during first year. The plots treated with thiamethoxam 25 WG and the lowest dose of cyantraniliprole 10% OD @ 45 g a.i./ha remained at par with each other and registered significantly higher (18.10 and 17.95 t/ha) yield than dimethoate 30 EC (12.60 t/ha) and untreated control (5.53 t/ha).

During second year, the data on yield of potato recorded in different treatments indicated that maximum (26.25 t/ha) yield was harvested from the plots sprayed with cyantraniliprole 10% OD @ 90 g a.i./ha and it was at par with treatments of cyantraniliprole 10% OD @ 75 and 60 g a.i./ha (24.83 and 24.38 t/ha). With respect to potato tuber yield, treatment of cyantraniliprole 10% OD @ 45 g a.i./ha and thiamethoxam 25 WG remained at par with each other and recorded significantly higher yield than dimethoate 30 EC (13.93 t/ha) as well as untreated control (7.42 t/ha).

Pooled data on yield of potato computed for two years revealed that the highest (25.92 t/ha) yield was harvested from the plots treated with cyantraniliprole 10% OD @ 90 g a.i./ha. However, it remained at par with cyantraniliprole 10% OD @ 75 and 60 g a.i./ha (24.96 and 24.59 t/ha). The plots treated with thiamethoxam 25 WG and cyantraniliprole 10% OD @ 45 g a.i./ha produced significantly higher (18.57 and 18.51 t/ha) yield over dimethoate 30 EC (13.27 t/ha) and untreated plot (6.48 t/ha).

It can be concluded among various evaluated doses of cyantraniliprole 10% OD during two years of experimentation, cyantraniliprole 10% OD @ 60 g a.i./ha found effective as it provided excellent protection against aphid, thrips and *H.*

armigera in potato. This treatment also manifested higher tuber yield without any phytotoxic symptoms on the plant and safer to natural enemies observed in the field. Based on their efficacy levels as well as low toxicity to natural enemies, we conclude that cyantraniliprole 10% OD insecticides can be incorporated in future IPM programme in potato cultivation.

Acknowledgement

The authors thankful to M/S E. I. DuPont India Private Limited, Gurgaon, Haryana for the financial assistance given for testing of its newer product cyantraniliprole (Cyazypyr™ 10% OD).

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How to cite this article:

Lodaya, J.P., N.B. Patel, R.D. Patel and Acharya, R.R. 2017. Bioefficacy of Cyantraniliprole 10% OD W/V (HGW86 10 OD) against Pests of Potato. *Int.J.Curr.Microbiol.App.Sci.* 6(7): 309-317.
doi: https://doi.org/10.20546/ijcmas.2017.607.036