



Effect of surfactant on the efficacy of insecticides against onion thrips (*Thrips tabaci*)

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Received: 14 October 2015; Accepted: 25 December 2015

ABSTRACT

The present experiment was carried out with an objective to find out the effect of surfactant on the efficacy of insecticides, because the use of insecticides for the control of onion thrips (*Thrips tabaci* Lindeman) is relatively less promising due to onion leaf pattern and texture. The minimum thrips population (6.48/plant) and thrips incidence (19.57%) were recorded at 15 days after spray in the fipronil 5 SC at 2 ml + surfactant at 0.5 ml/l of water, followed by lambda cyhalothrin 5 EC at 2 ml + surfactant at 0.5 ml (8.85/plant and 21.51%, respectively). While, imidacloprid 17.8 SL alone at 0.4 ml/l of water showed higher thrips population (21.78/plant) when compared to other treatments and which was found at par with untreated control. The efficacy of insecticides was significantly increased by addition of surfactant from 14.60 to 33.20 and 7.52 to 23.10% in minimizing the number of thrips/plant and thrips incidence %, respectively. The minimum thrips damage severity (1.36) and maximum bulb yield (254.83 q/h) with highest cost benefit ratio (1:6.84) was recorded in fipronil 5 SC at 2 ml + surfactant at 0.5 ml/l of water followed by lambda cyhalothrin 5 EC at 2 ml + surfactant at 0.5 ml (1.62, 249.50 q/ha and 1:6.14, respectively). Fipronil 5 SC and lambda cyhalothrin 5 EC without surfactant showed intermediate thrips damage severity (1.68 and 1.96, respectively), bulb yield (241.53 and 238.52 q/ha, respectively), and cost benefit ratio (1:5.68 and 1:5.26, respectively). The insecticides along with surfactant reduced the thrips damage severity (10.46–19.05%) and increased the bulb yield (1.97–5.51%) in different treatments when compared with the insecticides without surfactant. Along with insecticides the use of surfactant could be highly desirable.

Key words: Insecticides, Onion, Surfactants, Thrips

Onion thrips (*Thrips tabaci* Lindeman) considered to be the most important pest of onion (*Allium cepa* L.) and causes significant yield losses globally (Lewis 1997 and Trdan *et al.* 2005). Onion thrips causes 30–50% reduction in bulb yield during severe infestation (Nault and Shelton 2008, Karar *et al.* 2014). If onion thrips are not controlled, damage can routinely reduce bulb yield by 23–85% (Shiberu and Negeri 2014). The nymph and adult of onion thrips feed leaves by piercing and rasping the leaf tissues and causes lengthwise, silvery stippling or blotching on the onion leaves, resulting in the loss of chlorophyll and reduced photosynthetic efficiency (Boateng *et al.* 2014). An action threshold level of onion thrips is 15 thrips/plant has been suggested (Cranshaw 2004, Karar *et al.* 2014). The sprays of cypermethrin 3-4 times at 50 to

75 g a.i./ha were found effective against onion thrips (Abate and Ayalew 1994). Lambda cyhalothrin 5 EC had significantly reduced the onion thrips population (Mohamed 2006). Imidacloprid had the greatest overall effect in reducing the thrips damage severity and increased the bulb yield (Gachu *et al.* 2012). Confidor 200 SL (imidacloprid), Tracer 240 SC (spinosad), Thiodan 35 EC (endosulfan) were found effective against onion thrips in Pakistan (Ullah *et al.* 2010). The lowest thrips population (8 nymphs/plant) and highest bulb yield (362 q/ha) with highest cost benefit ratio (1:11.55) were achieved by applying fipronil at 1.5 ml/l of water (Pandey *et al.* 2013). In spite of all these insecticides onion thrips survives between the leaves in deep, due to this some of these were not affected during spray and remains live results in large scale multiplication. Besides this the leaf surface of onion is waxy and smooth which does not allow the insecticide to adhere properly and spread or the spray droplets rolls off on the surface of the leaves leads to the less residual effect of insecticides. Waxy leaf surfaces are readily wetted by aqueous sprays containing a suitable surface acting agent (Stevens *et al.* 1993). Surfactant reduces the surface tension of spray solution and gives an ideal coverage and

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penetration between the leaves. In addition to this, surfactants solubilize, suspend and disperse the active ingredient (a.i.) of pesticide (Katagi 2008). Surfactants are commonly applied along with pesticides to improve spray performance (Ryckaert *et al.* 2007). The inclusion of a surfactant is critical for improving the efficacy of insecticides that have systemic and translaminar movement within onion plants to control onion thrips (Nault *et al.* 2013). The evaporation time and maximum coverage area of droplets significantly changed by adding the surfactant to the sprays (Yu *et al.* 2009). Therefore, the present study was carried out to find out the role of surfactant in the efficacy of insecticides against onion thrips.

MATERIALS AND METHODS

The on farm trials (OFTs) were conducted in two consecutive years during *rabi* season 2013–14 and 2014–15 at Krishi Vigyan Kendra, Chomu, Jaipur (Rajasthan) using onion variety RO–252. The insecticides, viz. imidacloprid 17.8 SL @ 0.4 ml/water (28.48 g a.i./ha), lambda cyhalothrin 5 EC at 2 ml/l water (40 g a.i./ha) and fipronil 5 SC at 2 ml/l water (40 g a.i./ha) were used with and without surfactant. The non-ionic surfactant at the rate of 0.5 ml/l of water was used for the study. The trails were laid out in a Randomized Block Design with seven treatments including untreated control and three replications. Here we have used the higher dose of lambda cyhalothrin because a lower dose of the same was found less effective against onion thrips. Forty five days old onion seedlings were transplanted at a spacing of 30 × 15 cm and the plot size was 6.0 × 3.0 meter. All the recommended agronomical practices like fertilizer application, irrigation, weeding, hoeing, etc. except thrips management practices were timely followed to raise a successful crop. Two sprays of different treatments were applied at 30 and 45 days after transplanting.

The assessment of thrips population was carried by random destructive sampling of 5 plants/plot from the inner rows of each plot. According to this method, the stem was cut at the crown and the whole shoot was put in 70% ethanol followed by filtering the contents through a 220 mesh sieve and the suspension obtained was allowed to settle. The suspension was transformed to a Petri dish and the number of thrips counted under a stereo zoom trinocular microscope (4.5X). The per cent reduction in thrips population (15 days after spray) was calculated by Henderson and Tilton (1955) formula. The thrips damage was assessed on the basis of symptoms, i.e. the silvery patches characteristically caused by thrips on onion leaves. The thrips damage incidence was determined by counting the number of affected plants over the total number of plants/plot. The thrips damage severity was determined by random selection of 10 plants from the inner rows of each plot. It was assessed by using 1–5 rating scale (Smith *et al.* 1994), where 1 = no damage, 2 = up to 25% damage, 3 = 26–50% damage, 4 = 51–75% damage and 5 = > 75% damage. All the data pertaining to the thrips

population, thrips damage incidence per cent and thrips damage severity were taken before spray, 24 hr after spray and three, five, seven, 10 and 15 days after spray. The optimum time for harvesting is when leaves start turning yellow and becoming dry at the top. The bulb yield in q/ha was determined after digging of the bulb. All the data were subjected to analyze by using analysis of variance (ANOVA).

RESULTS AND DISCUSSION

Effect on thrips population and thrips incidence per cent

The pooled data presented in Table 1 revealed that all the treatments except imidacloprid alone were significantly reduce the thrips population compared to untreated control, whereas there is a significant reduction in the thrips incidence percentage in all the treatments. In untreated control both the thrips population and thrips incidence per cent was gradually increased over time. The minimum thrips population (6.48/plant) and thrips incidence (19.57%) were recorded at 15 days after spray in the fipronil 5 SC at 2 ml + surfactant at 0.5 ml/liter of water, followed by lambda cyhalothrin 5 EC at 2 ml + surfactant at 0.5 ml (8.85/plant and 21.51%, respectively), and both were found on par with each other and were equally effective. Fipronil 5 SC at 2 ml/liter of water and lambda cyhalothrin 5 EC at 2 ml/liter of water both without surfactant also showed significantly better control on thrips population (9.70/plant and 12.67/plant, respectively), and thrips incidence (25.13% and 27.97%, respectively). Imidacloprid 17.8 SL at 0.4 ml along with surfactant was found less effective when compared with above treatments but significantly better (18.60/plant and 62.75%) than imidacloprid 17.8 SL alone at 0.4 ml and untreated control. In untreated control the thrips population and incidence were 24.72/plant and 82.91%, respectively. While, imidacloprid 17.8 SL without surfactant at 0.4 ml/liter of water showed higher thrips population (21.78/plant) when compared to other treatments and found on par with untreated control. The per cent reduction in thrips population was ranged from 17.47 to 74.03 in different treatments at 15 days after spray, it was found maximum (74.03%) in fipronil + surfactant and minimum (17.47) in imidacloprid alone. It was also observed that all the insecticides with and without surfactant was given best control on thrips population up to seven days after spray, while after 10 and 15 days of spray, there was a increase in thrips population. Whereas, the thrips incidence per cent was found minimum up to 10 days of spray. The minimum number of thrips (0.28/plant) after 7 days of spray and minimum thrips incidence (12.95%) after 10 days of spray was recorded in fipronil + surfactant treated plants. The efficacy of insecticides was significantly increased by addition of surfactant from 14.60 to 33.20% in minimizing the number of thrips per plant and 7.52 to 23.10% in minimizing the thrips incidence after 15 days of spray. These findings have close concern with the findings of earlier workers who have reported that fipronil and imidacloprid

Table 1 Effect of different insecticides with and without surfactant on number of thrips per plant and thrips incidence per cent (Pooled data of 2013-14 and 2014-15)

Treatment	24 hours before spray		No. of thrips/plant (Pooled mean)					Per cent reduction in thrips population (15 DAS)		Thrips incidence per cent (Pooled Mean)						
	24 hours before spray	15	Days after spray (DAS)					24 hours before spray	15	Days after spray (DAS)						
			1	3	5	7	10			15	1	3	5	7	10	15
Imidacloprid 17.8 SL at 0.4 ml/l water	19.75	15.96	14.47	13.07	12.49	16.58	21.78	17.47	69.75 (56.63)*	69.92	69.27	68.35	51.7	59.50	67.85	(55.46)
Imidacloprid 17.8 SL at 0.4 ml + Surfactant at 0.5 ml/l water	17.61	15.18	10.38	8.72	7.45	13.92	18.60	20.95	71.67 (57.84)	71.52	71.56	66.84	48.65	52.97	62.75	(52.39)
Lambda Cyhalothrin 5 EC at 2 ml/l water	21.47	14.41	7.08	4.91	3.27	7.80	12.67	55.84	74.20 (59.47)	74.20	73.15	70.27	36.92	19.92	27.97	(31.92)
Lambda Cyhalothrin 5 EC at 2 ml + Surfactant at 0.5 ml/l water	22.00	12.93	5.76	3.17	1.67	4.36	8.85	69.89	74.98 (59.98)	74.00	72.95	65.05	26.41	14.56	21.51	(27.63)
Fipronil 5 SC at 2 ml/l water	17.36	12.52	0.92	0.74	0.60	3.51	9.70	58.18	67.85 (55.46)	67.80	67.52	62.74	27.85	16.37	25.13	(30.08)
Fipronil 5 SC at 2 ml + Surfactant 0.5 ml/l water	18.67	11.47	0.74	0.57	0.28	1.10	6.48	74.03	68.33 (55.75)	68.33	68.07	60.53	23.96	12.95	19.57	(26.25)
Untreated control	18.50	19.33	18.80	20.50	21.94	22.50	24.72		65.90 (54.27)	65.90	67.42	68.96	72.81	71.78	82.91	(65.58)
CD (P=0.05)	2.51	2.64	2.28	3.07	2.31	2.94	3.10		3.27	2.92	3.21	2.70	2.86	3.03	3.28	

*Angular transformed values are in parenthesis.

reduced the thrips population (Ullah *et al.* 2010 Gachu *et al.* 2012 and Pandey *et al.* 2013). The efficacy of cypermethrin (synthetic pyrethroid) against onion thrips was reported (Abate and Ayalew 1994). Mohamed (2006) also reported that lambda cyhalothrin 5 EC had significantly reduced the onion thrips population. The impact of surfactants in improving the efficacy of insecticides was reported by earlier workers (Ryckaert *et al.* 2007, Katagi *et al.* 2008, Yu *et al.* 2009, Nault *et al.* 2013).

Effect on thrips damage severity and bulb yield

The pooled data presented in Table 2 revealed that all the treatments significantly reduced the thrips damage severity (1.36–3.06) and increased the bulb yield. The minimum thrips damage severity (1.36) after 15 days of spray and maximum bulb yield (254.83 q/ha) was recorded in fipronil 5 SC at 2 ml + surfactant at 0.5 ml/liter of water followed by lambda cyhalothrin 5 EC at 2 ml + surfactant at 0.5 ml (1.62 and 249.50 q/ha, respectively), both the treatments were found on par with each other and found promising in controlling the damage caused by thrips. Fipronil 5 SC at 2 ml/liter of water and lambda cyhalothrin 5 EC at 2 ml/liter of water both without surfactant showed the intermediate damage severity (1.68 and 1.96, respectively), and bulb yield (241.53 and 238.52 q/ha, respectively). Imidacloprid 17.8 SL at 0.4 ml with and without surfactant showed the higher rate of thrips damage severity and lower bulb yield when compared to other treatments but are found significantly superior to untreated control. The reduction in the thrips damage severity was recorded up to 10 days after spray where the minimum thrips damage severity (1.23) was recorded in fipronil + surfactant but the observations of 15 days after spray showed a slight increase in the damage severity in all the treatments. The insecticides with surfactant reduced the thrips damage severity (10.46–19.05%) and increased the bulb yield (1.97–

5.51%) in different treatments when compared with the insecticides without surfactant. The cost benefit ratio also showed similar trend, it was highest (1:6.84) in fipronil + surfactant followed by lambda cyhalothrin + surfactant (1:6.14), fipronil alone (1:5.68) and lambda cyhalothrin alone (1:5.26). The minimum cost benefit ratio was found in imidacloprid with and without surfactant (1:1.48 and 1:0.22, respectively). The finding shows similarity with the finding of Pandey *et al.* (2013) who have reported that lowest thrips population and highest bulb yield with highest cost benefit ratio were achieved by applying fipronil. The other workers also reported that fipronil and imidacloprid reduced the thrips damage severity and increased the onion bulb yield (Ullah *et al.* 2010 Gachu *et al.* 2012). The impact of surfactants in improving the efficacy of insecticides has been reported by earlier workers (Ryckaert *et al.* 2007, Katagi *et al.* 2008, Yu *et al.* 2009, Nault *et al.* 2013).

One of principle problem in onion thrips control is the mobile stages of thrips which are found mainly in the narrow space between inner leaves, where spray coverage is difficult to accomplish. Besides this the leaf surface of onion is waxy and smooth which does not allow the insecticide to adhere properly and spread or the spray droplets were roll off on the surface of the leaves due to this the residual effect of insecticide is less. Use of surfactant with insecticides is the best way to combat the above problem. This study showed that the efficacy of insecticides was significantly increased by addition of surfactant from 14.60 to 33.20 and 7.52 to 23.10% in minimizing the number of thrips per plant and thrips incidence per cent, respectively. Whereas, insecticides along with surfactant reduced the thrips damage severity (10.46–19.05%) and increased the bulb yield (1.97–5.51%) in different treatments when compared with the insecticides without surfactant. Surfactants could improve deposition of sprays applied to the onion leaves and there with improve

Table 2 Effect of different insecticides with and without surfactant on thrips damage severity and bulb yield q/ha (Pooled data of 2013–14 and 2014–15)

Treatment	24 hours before spray	Thrips damage severity (Pooled mean)						Bulb yield (q/ha) (Pooled mean)	C:B ratio
		Days after spray							
		1	3	5	7	10	15		
Imidacloprid 17.8 SL at 0.4 ml/l water	3.17	3.18	3.12	3.06	2.93	2.88	3.06	213.21	1:0.22
Imidacloprid 17.8 SL 0.4 ml + Surfactant at 0.5 ml/l water	3.11	3.11	3.03	2.97	2.59	2.55	2.74	217.42	1:1.48
Lambda Cyhalothrin 5 EC at 2 ml/l water	2.98	2.98	2.67	2.18	1.84	1.79	1.96	238.52	1:5.26
Lambda Cyhalothrin 5 EC at 2 ml + Surfactant at 0.5 ml/l water	3.05	3.07	2.66	2.05	1.57	1.48	1.62	249.50	1:6.14
Fipronil 5 SC at 2 ml/l water	3.14	3.14	2.97	2.12	1.73	1.51	1.68	241.53	1:5.68
Fipronil 5 SC at 2 ml + Surfactant at 0.5 ml/l water	3.16	3.15	2.95	1.96	1.45	1.23	1.36	254.83	1:6.84
Untreated control	2.89	2.89	2.97	3.10	3.19	3.32	3.50	211.30	
CD (P=0.05)	0.21	0.20	0.18	0.22	0.24	0.25	0.29	5.47	

the efficacy of insecticides against onion thrips. Surfactants maximized the efficacy by helping in solubilizing and spreading the insecticides so that it suspend and disperse evenly on the leaf surface of onion. Therefore, the use of surfactants is a promising tactics and implicated practically along with insecticides. However, it needs focus and require more research work in this direction.

REFERENCES

- Abate T and Ayalew G. 1994. Progress in vegetable pest management research 1985-1992. (In) *Horticulture Research and Development in Ethiopia*. Hearth E and Dessalegne L (Eds). Proceeding of the 2nd National Horticulture Workshop, 1-3 December 1992, IAR/FAO, Addis Ababa, Ethiopia, pp 187-93.
- Boateng C O, Schwartz H F, Havey M J and Otto K. 2014. Evaluation of onion germplasm for resistance to Iris Yellow Spot Virus (Iris yellow spot virus) and onion thrips, *Thrips tabaci*. *Southwestern Entomologist* **39**: 237-60.
- Cranshaw W S. 2004. Onion thrips in onions XXV. Agricultural Experiment Station, Colorado State University, Fort Collins, CO. (<http://wiki.bugwood.org/uploads/OnionThrips-Onions.pdf>).
- Gachu S M, Muthomi J W, Narla R D, Nderitu J H, Olubayo F M and Waga J M. 2012. Management of thrips (*Thrips tabaci*) in bulb onion by using of vegetable inter crops. *International Journal of AgriScience* **2**(5): 393-402.
- Henderson C F and Tilton E W. 1955. Tests with acaricides against the brow wheat mite. *Journal of Economic Entomology* **48**: 157-61.
- Karar Haider, Abbas Ghulam, Hameed Asifa, Ahmad Ghayour and Ali Amjad. 2014. Losses in onion (*Allium cepa*) due to onion thrips (*Thrips tabaci*) (Thysanoptera: Thripidae) and effect of weather factors on population dynamics of thrips. *World Applied Sciences Journal* **32**(11): 2 250-8.
- Katagi Toshiyuki 2008. Surfactant effects on environmental behavior of pesticides. *Review of Environmental Contamination and Toxicology* **194**: 71-177.
- Lewis T. 1997. *Thrips as Crop Pests*. CAB International, New York, NY.
- Mohamed A.S. 2006. Evaluation of the insecticide eureka (lambda-cyhalothrin (iso) 5 EC for the control of onion thrips (*thrips tabaci*) on onion. <http://agris.fao.org/aos/records/SD2011000054>. pp. 66-70.
- Nault B A and Shelton A M. 2008. Insecticide efficacy and timing of sprays for onion thrips control. (In) *Proceedings, 2008 Empire State Fruit and Vegetable Expo*, 12-14 February 2008. Syracuse, NY, pp 52-6.
- Nault B A, Hsu C and Hoepting C. 2013. Consequences of co-applying insecticides and fungicides for managing *Thrips tabaci* (Thysanoptera: Thripidae) on onion. *Pest Management Science* **69**: 841-9.
- Pandey Sujay, Singh B K and Gupta R P. 2013. Effect of neem based botanicals, chemicals and bio-insecticides for the management of thrips in onion. *Indian Journal of Agriculture Research* **47**(6): 545-8.
- Ryckaert B, Spanoghe P, Haesaert G, Heremans B, Isebaert S and Steurbaut W. 2007. Quantitative determination of the influence of adjuvants on foliar fungicide residues. *Crop Protection* **26**: 1 589-94.
- Shiberu Tadele and Negeri Mulugeta 2014. Evaluation of insecticides and botanicals against onion thrips, *Thrips tabaci* (L.) (Thysanoptera: Thripidae). *Entomology and Applied Science* **1**(2): 26-30
- Smith C M, Khan Z R and Pathak M D. 1994. *Techniques for Evaluating Insect Resistance in Crop Plants*. CRC Press, Boca Raton, Florida, USA.
- Stevens P J G, Kimberley M O, Murphy S and Policello G A. 1993. Adhesion of spray droplets to foliage: The role of dynamic surface tension and advantages of organosilicone surfactants. *Pesticide Science* **29**: 58-67.
- Trdan S, Vali N, Zezlina I, Bergant K and Znidar D. 2005. Light blue sticky boards for mass trapping of onion thrips, *Thrips tabaci* Lindeman (Thysanoptera: Thripidae), in onion crops. *Journal of Plant Diseases and Protection* **12**: 173-80.
- Ullah Farman, Mulk Maraj-ul, Farid Abid, Saeed Mohammad Qasid and Sattar Shahid. 2010. Population dynamics and chemical control of onion thrips (*Thrips tabaci* Lindemann). *Pakistan Journal of Zoology* **42**(4): 401-6.
- Yu Y, Zhu H, Frantz J M, Reding M E, Chan K C and Ozkan H E. 2009. Evaporation and coverage area of pesticide droplets on hairy and waxy leaves. *Biosystems Engineering* **104**: 324-34.