



Bio-Efficacy of Neonicotinoids and Insect Growth Regulators against *Bemisia tabaci* Genn. on *Solanum Melongena* L.

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ABSTRACT

Recently, great attention has been paid towards exploitation of Bio-rational insecticides in plant pest management in perspective of the public concern over the level of pesticide residues in food and environment causing health and ecological problems. The indiscriminate use of synthetics insecticides in crop protection has also led to development of resistant strains of pests and have adverse effects on non-target organisms including natural enemies and pollinators. Amongst bio-rational insecticides, neonicotinoids and insect growth regulators (IGRs) may be exploited as eco-friendly approach in crop pest management. We therefore, evaluated the effectiveness of nitenpyram, Clothianidin, Momentum (Mixture of Nitenpyram and Chlorfenapyr) and Buprofezin against brinjal whitefly (*Bemisia tabaci* Genn.). The crop was grown in a randomized complete block design (RCBD) with three replicates each having five treatments with control. Pre-treatment data were collected before 24 h and Post treatment data were collected after 24, 72, 168 and 336 h of each spray. In this manner, the data for three sprays were collected. The order of effectiveness in decreasing sequence was found to be Nitenpyram, Buprofezin, clothianidin and momentum (75%), (65%) (64%) and (63%), respectively against whiteflies' population.

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Authors' Contribution

MFA conceived and designed the study. MSS conducted experiments, collected and analyzed the data and wrote the article.

Key words

Bemisia tabaci (Genn.), Bio efficacy, Insect growth regulators (IGRs), Neonicotinoids, Selected insecticides, Brinjal.

INTRODUCTION

Brinjal (*Solanum melongena* L.) belongs to the family solanacea and one of the most widely cultivated crops around the world (EGGNET, 2005). It is the most important vegetable crop grown in Asia, Africa and Mediterranean countries (Collonier *et al.*, 2001). In Pakistan the cultivated area under brinjal crop has been reported 8325 hectares with an annual production of 82999 tonnes and the average yield 9969.8 Kg/ha (FAOSTAT, 2017). Different cultivars of Brinjal grown in Pakistan, contain the wide range of fruit shapes ranging from oval, egg-shaped to long club-shaped with white, yellow, green, purple pigmentation to almost black colors. Brinjal is adapted to high rainfall and high temperature. Besides that, it has potential to produce high yield under hot-wet environment (Peter *et al.*, 2006). However, brinjal production effects due to the severe attack of sucking insect pests. Among these whitefly (*Bemisia tabaci* Genn.) is the most destructive one (Abhijit and Chatterjee, 2012; Norhelina *et al.*, 2013). Both nymphs and adults feed on the lower surface of the leaves and suck the sap from sieve tubes. They also secrete the honey dew, thus lower down photosynthetic activity of the plants (Khan *et al.*, 2011).

Whitefly acts as a vector for some pathogens and viruses that cause damage to the plant (Fauziah *et al.*, 2009). An estimated 70% to 92% yield losses has been reported due to whitefly infestation (Omprakash and Raju, 2014).

Although insecticidal application is the most common practice to control the whitefly, but the toxic nature of insecticides and their continuous and injudicious use are harmful for the human health and the environment as well. As the vegetable crops are consumed just after few days of harvest, hence, there is always a risk of exceeding MRLs, which is ultimately hazardous to human health. Continuous intake of insecticide residues even in trace elements may accumulated in human body tissues and cause severe health effects (Handa *et al.*, 1999). It was also confirmed by Akbar *et al.* (2010a, b, 2012a) that the residues of Organochlorine and Organophosphate insecticides in different vegetables are higher than maximum residual limits (MRLs) set by Codex (FAO) and EU. Moreover, Masud and Hasan (1992) also reported higher levels of insecticides residues in different vegetables.

In Pakistan, management of whitefly (*Bemisia tabaci* Genn.) is much relies on conventional insecticides. Continuous and injudicious application of chemical have also developed resistance to conventional insecticides. Neonicotinoids are the new class of insecticides with novel mode of action, broad spectrum, good trans laminar ability, long systemic activity (Kodandaram *et al.*, 2010). Selectivity, lower dose and safer to non-target organisms

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is very appropriate in integrated pest management (IPM) and insect resistance management (IRM) resulting in less harmful for environment. On the other hand insect growth regulators (IGRs) were also found most effective against nymphal stages of whitefly (Nadeem *et al.*, 2011; Ramalakshmi *et al.*, 2012).

Keeping in view the significance of export and economic value of the brinjal crop and other threats to environment and non-target organisms by broad spectrum insecticides; present study was planned to evaluate the effectiveness of neonicotinoids and IGRs against whitefly on brinjal crop.

MATERIALS AND METHODS

Experimental sites

Experiments were conducted at the agricultural Field of Department of Agriculture and Agribusiness Management, University of Karachi during 2016-17.

Plant materials

A local Variety “Black King” F1 hybrid brinjal was used as a host for the pest. Seeds were obtained from local market. The brinjal seeds were sown in small pots. After 35 days, the seedlings were transplanted to the field with a row to row distance of 75 cm and plant to plant distance of 60 cm and

Field experiment layout and design

The experimental plots were arranged in a randomized complete block design (RCBD), with three replicates, each comprising five treatments including control.

Application of insecticides and their specifications

The insecticides (Table I) were applied at prescribed dose mentioned on the products' label when the population of whitefly reached at economic threshold level (ETL) *i.e.* 5 to 10 whiteflies per leaf (Shivanna *et al.*, 2011).

Data collection

The observations of whitefly were recorded on ten randomly selected plants from each treated plot. Three leaves from each plant were observed from top, middle and bottom (Kaushik and Kaushik, 1990). The whitefly

population was carefully counted on under side of the leaves. Finally, the collected data were expressed as mean populations from each plot. Pre-treatment counts were taken before 24 h, while post-treatment observations were made after 24, 72, 168 and 336 h of each spray.

The obtained data were compiled as a mean populations and reduction percentage was calculated by Henderson-Tilton's formula (Henderson and Tilton, 1955) according to following equation:

$$\% \text{reduction in population} = 100 \times 1 - \left(\frac{T_a \times C_b}{T_b \times C_a} \right)$$

Where, T_a is number of insects after treatment, T_b is number of insects before treatment, C_a is number of insects in untreated check after treatment and C_b is number of insects in untreated check before treatment.

Statistical analysis

The collected data were subjected to statistical analysis through SPSS version 16.0. The mean differences between various treatments were tested by using Tukey's HSD test at 5% significance Level.

RESULTS AND DISCUSSION

The results in Table II reveals that all the treatments had significant effect ($P < 0.05$) against whiteflies' population even till 14 days.

After 24 h of first spray, maximum reduction in whitefly population was recorded in the plots treated with Nitenpyram (70.02%), Clothianidin (57.95%) and Momentum (Nitenpyram + Chlorfenapyr) (57.25%), while Buprofezin gave minimum reduction with (41.20%). After three days, maximum reduction was recorded as nitenpyram (78.41%), clothianidin (69.63%) and momentum (64.86%), followed by Buprofezin (54.52%). While, after seven days, nitenpyram gave (68.98%) reduction and Buprofezin (64.89%) followed by clothianidin (63.64%) and momentum (59.41%), which were significantly different ($P < 0.01$) as compared to control. However, after 14 days, the maximum reduction was recorded in the plots treated with Buprofezin (66.08%) and clothianidin (64.10%), followed by nitenpyram (63.04%) and momentum (61.19%).

Table I.- Insecticides used against whitefly on brinjal crop.

S. No.	Common name	Trade name	Group	Source	Dose g ha ⁻¹ a.i.
1.	Nitenpyram	Pyramid 10% SL	Neonicotinoids	Kanzo AG	49.4
2.	Clothianidin	Telsta	Neonicotinoids	Sun Crop	24.7
3.	Nitenpyram + Chlorfenapyr	Momentum 50% WDG	Neonicotinoids and Pyrrole	Kanzo AG	7.41
4.	Buprofezin	Applaud	IGRs	Arysta	59.28

Table II.- Mean and percentage reduction of whitefly populations on brinjal leaves after applications of different insecticides.

Treatments	Mean and reduction percentage of whiteflies (<i>Bemisia tabaci</i>) per 10 leaves				Commutative mean	Percent reduction over control
	24 h	72 h	168 h	336 h		
First spray						
Nitenpyram	9.00 ^a (70.02)	5.33 ^a (78.41)	3.66 ^a (83.89)	9.66 ^a (63.04)	6.87 ^a	73.85
Clothianidin	15.66 ^{bc} (57.95)	11.33 ^{bc} (69.63)	1.33 ^a (63.34)	12.00 ^a (64.10)	12.80 ^{ab}	63.76
Momentum	9.66 ^a (57.25)	8.00 ^{bc} (64.86)	8.66 ^a (59.41)	8.33 ^a (61.19)	8.62 ^a	60.68
Buprofezin	21.66 ^b (41.20)	16.66 ^b (54.52)	11.66 ^a (64.89)	12.33 ^a (66.08)	15.52 ^b	56.67
Control	42.33 ^a (0.00)	43.30 ^c (0.00)	39.00 ^b (0.00)	40.00 ^b (0.00)	41.15 ^c	-
Second spray						
Nitenpyram	4.00 ^a (82.89)	3.66 ^a (79.82)	5.33 ^a (77.49)	8.00 ^a (71.99)	5.22 ^a	78.05
Clothianidin	11.00 ^a (65.00)	9.00 ^a (71.04)	11.66 ^a (61.39)	15.33 ^a (58.81)	11.72 ^b	64.06
Momentum	6.33 ^a (64.92)	7.33 ^a (60.52)	7.33 ^a (63.12)	9.00 ^a (59.19)	7.47 ^{ab}	61.94
Buprofezin	11.66 ^a (58.89)	9.66 ^a (66.15)	9.66 ^a (68.31)	11.00 ^a (70.40)	10.45 ^b	65.94
Control	36.33 ^a (0.00)	34.66 ^b (0.00)	35.66 ^b (0.00)	42.33 ^b (0.00)	37.20 ^c	-
Third spray						
Nitenpyram	16.00 ^a (75.51)	13.00 ^a (80.92)	5.33 ^a (85.94)	5.33 ^a (81.75)	9.00 ^a	81.03
Clothianidin	27.00 ^a (65.47)	25.66 ^a (68.15)	19.00 ^a (67.24)	11.66 ^a (60.67)	20.95 ^a	65.38
Momentum	18.00 ^a (65.15)	15.33 ^a (68.78)	8.66 ^a (71.27)	8.00 ^a (58.40)	12.47 ^a	65.90
Buprofezin	26.33 ^a (68.69)	16.33 ^a (81.44)	16.00 ^a (74.94)	10.00 ^a (69.14)	17.15 ^a	73.55
Control	96.66 ^b (0.00)	96.00 ^b (0.00)	68.33 ^b (0.00)	37.33 ^b (0.00)	74.55 ^b	-

*, means sharing similar alphabets in each column are not significantly difference (Tukey's HSD, $P > 0.05$). **, values in parenthesis represent percent reduction of whiteflies in each treatment.

Similar trend was observed after 2nd spray. Nitenpyram maintained its superiority over rest of insecticides with an increasing trend with 82.89%, 79.82%, 77.49% and 71.99% reduction in whitefly population after 1, 3, 7 and 14 days of 2nd spray, while effectiveness decreased after 7 days of spray as the time increased. Although clothianidin and momentum (Nitenpyram+Chlorfenapyr) were effective with 65.00%, 71.04%, 61.39% and 58.81%, and 64.92%, 60.52%, 63.12% and 59.19% reduction, respectively. Buprofezin performed well as compared to 1st spray with 58.89%, 66.15%, 68.31 and 70.40% insect mortality.

Nitenpyram sustained its dominance with increasing trend till 3rd spray and reduced whitefly population by 75.51%, 80.92%, 85.94% and 81.75%. Clothianidin and Momentum gave similar results with gradual decrease in effectiveness as compared to previous treatments with 65.47%, 68.15%, 67.24% and 60.67%, and 65.15%, 68.78%, 71.27% and 58.40% insect mortality. However, buprofezin gave satisfactory results with gradual increasing trend in effectiveness with 68.69%, 81.44%, 74.94% and 69.14% reduction in jassid population. Buprofezin showed higher mortality of whiteflies at third and second spray till 14 days.

After three consecutive sprays, an overall performance of all the insecticides represents that nitenpyram was highly effective against whiteflies, followed by buprofezin, clothianidin and momentum (Nitenpyram+Chlorfenapyr) 75±4.5, 65±6.9, 64±0.4 and 63±2.2, respectively.

The variable toxic effects against whiteflies, might be due to different characteristics of neonicotinoids which influence the movement in plant tissues such as solubility of the water that greatly affects the toxicity in sucking and piercing type insects like whiteflies (Cloyd-Raymond and Bethke, 2011). The tested neonicotinoids insecticides showed inconsistent reduction of whitefly population during three sprays in the similar cropping season. Based on the results, it was observed that the reduction percentage of whitefly population is higher in first spray than the second and third sprays. This may be due to the surrounding temperature and high intense sunlight that reduced toxicity of insecticides compounds. These findings are supported by the Wei and Liu (1999), who reported that hydrolysis of neonicotinoids insecticides increases with the increased surrounding temperature, which affects the toxicity level of insecticides.

The findings of the present study showed that

nitenpyram was effective with maximum mortality till 14 days as compared to rest of insecticides, which is in consistence with the findings of [Amit and Raghuraman \(2014\)](#), they reported that nitenpyram significantly reduced the whiteflies population in vegetable crops. This was also confirmed that [Asif et al. \(2017\)](#), neonicotinoids *i.e.* nitenpyram are very effective in reducing the population of whitefly below economic threshold level. Moreover, [Irshad et al. \(2015\)](#) observed that nitenpyram reduced the sucking insects population below ETL after seven days of application. Whereas, [Kadam et al. \(2014\)](#) found nitenpyram significantly effective against sucking insects over a span of 14 days. Clothianidin proved its effectiveness after nitenpyram against brinjal whitefly, which confirms the similar studies conducted by [Vijay and Ilyas \(2017\)](#), [Patnaik et al. \(2011\)](#) and [Shaikh et al. \(2014\)](#). It was also found by [Pachundkar et al. \(2013\)](#) that the higher effectiveness of clothianidin 50 WDG (0.025%) against the whitefly. These findings also supported by [Akbar et al. \(2008, 2010a, 2014\)](#) that imidacloprid (neonicotinoid) most effective against *Myzus persicae* (Sulzer) on mustard, cabbage and cauliflower as compared to endosulfan. They also reported its excellent efficacy against *Bemisia tabaci* Genn. on okra and brinjal ([Akbar et al., 2009, 2011, 2015a](#)) and *Amrasca devastans* Distt. on potato, okra and brinjal ([Akbar et al., 2012a, b, 2015b](#)). Momentum (a mixture of nitenpyram and chlorfenapyr) showed moderate effectiveness during the present study, that is in the line of previous findings that confirms its good performance against whitefly till one week after application ([Anonymous, 2016](#)).

Buprofezin significantly reduced the whiteflies' population after nitenpyram and clothianidin. These findings are in conformity with [Maji et al. \(2015\)](#), who reported buprofezin as highly effective against sucking insects of okra. [Nadeem et al. \(2011\)](#) found that buprofezin was the most effective insecticides against nymphs of whitefly in Pakistan. [Ramalakshmi et al. \(2012\)](#) found buprofezin 25% SC significantly effective in reducing leafhopper (*A. devastans*) population on cotton crop. [Gopal and Islam \(2014\)](#) also found that buprofezin was the best insecticide for the management of brinjal whiteflies. In another study, [Amit and Raghuraman \(2014\)](#) reported significant mortality of whitefly through buprofezin. This is due to the mode of action of buprofezin that once whitefly poisoned, they become unable to produce new cuticle, thereby effectively preventing them from molting to the next stage and finally they die due to poisoning of buprofezin.

Figure 1A presents the time wise effectiveness of all four tested insecticides. Increasing trend was observed in all the insecticides till 336 h post application. Whereas,

the spray wise efficacy of the tested insecticide (Fig. 1B) showed higher mortality of whitefly after the third spray while first and second spray showed less effectiveness.

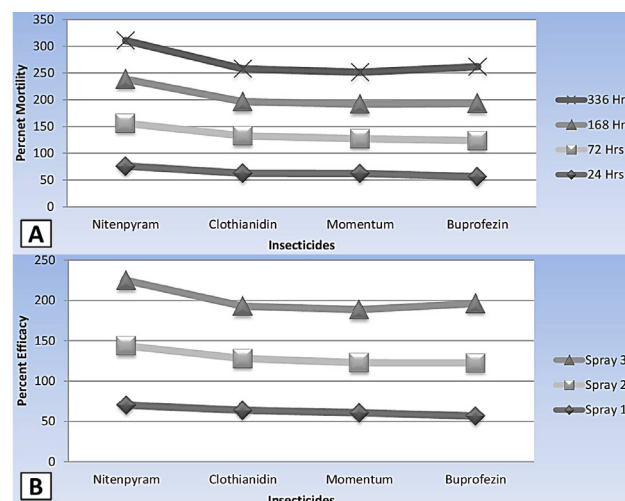


Fig. 1. Time wise (A) and spray wise (B) efficacy of various insecticides against whitefly on brinjal crop.

CONCLUSION

It could be concluded that being bio rational, all the tested insecticides including Insect Growth Regulators (IGRs) can successfully be incorporated in an Integrated Pest Management (IPM) strategy. During the present study, Nitenpyram and Buprofezin has proved them most effective in suppressing whiteflies' populations on brinjal crop.

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Statement of conflict of interest

The author(s) declare(s) that there is no conflict of interests regarding the publication of this article.

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