Insecticidal Effect on Natural Enemies in Rice Ecosystem of Kanpur (Central Uttar Pradesh)

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Abstract

The maximum number of natural enemies was recorded in chlorantraniliprole 18.5% SC treated plots except checked (untreated or control) followed by buprofezin 25 SC, imidacloprid 17.8SL, cartap hydrochloride 4G, malatian 5% D and fipronil 5 SC, respectively in both the experimental years.

Keywords

Insecticidal effect, Natural enemies, Rice ecosystem

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Introduction

Rice (Oryza sativa L.) is the world’s second most important cereal crop, cultivated in the most diverse ecosystems of tropical and subtropical regions of 117 countries and known with different names in India as Dangar (Gujarat), Bhatt (Maharashtra), Chawal (U.P., Bihar), Voldu (A.P.), Dhan (W.B.), Chaul (Punjab), Shali (J & K), Nellu (Tamil Nadu, Kerala). It is one of the oldest and second most intensively grown cereal crops next to wheat and ranks third in grain production. Rice is life and princess among the cereals, the staple food of 65% of the total population in India. It constitutes about 52% of the total food grain production and 55% of total cereal production. Rice is grown under diverse growing conditions such as irrigated, rainfed lowland, rainfed upland and flood prone ecosystems. India is the largest rice growing country, while China is the largest producer of rice in the world. India produced 105.42 million tones during 2015-16 from 43.70 million hectare with average productivity (2412 kg/ha (Anonymous, 2017a). Over 800 species of pests and numerous species of natural enemies occupy the rice crop during vegetative and reproductive stages (Hafeez et al., 2010). The natural enemies, predators and parasitoids will impart the effect over the population of rice pests
under favourable environmental conditions. The use of insecticides remains the major strategy in dealing with insect-pests as it is quick, cost-effective and effective. However, lethal and sub-lethal effects of broad-spectrum insecticides may impact beneficial species (Wang et al., 2012 and Fogel et al., 2013). Misuse of insecticides might account for pest outbreaks because extensive and intensive insecticides applied to target pests and may accelerate resistance development. Another important factor is environmental pollution, side effect on non-target organism and insecticides may indiscriminately kill natural enemies. In fact, natural enemies tend to be more susceptible to insecticides than pests (Kiritani, 1979, Bacci, L. et al., 2007 and Preetha et al., 2010). Some insecticides have disrupted natural enemy complexes and induced a resurgence of the target pests or non-target minor pests in paddies (Gallagher et al., 1994 and Heinrichs, 1994). Insecticides and biological control are two important management strategies. Integrating these two strategies is important for the success of any management program (Wright & Verkert, 1995). In contrast use of selective insecticides that are less toxic to natural enemies than to pests should conserve natural enemy populations, and the surviving natural enemies may suppress the pest populations, which in turn will reduce the rate of insecticide application. Insecticides should be only used when necessary and be least disruptive to biological control (Wang et al., 2008). Knowing the impact of insecticides on natural enemies is essential for integration of these two strategies (Greathead, 1995). It is essential to understand the dynamics of integrating prudently used chemical pesticides along with biological control organisms for the effective implementation of an IPM. To effective utilize the natural enemies as biological control agents, we should acquire information about the effects of pesticides on them. Many investigations have assessed the effect of insecticides on predators of rice insect-pests simply by applying insecticides paddy fields (e.g. Ito et al., 1962; Toyoda and Yoshimura, 1966, 1967; Heinrichs et al., 1982a, b; Reissig et al., 1982a, b and Tanaka & Sato, 1988).

Materials and Methods

A field experiment was carried out during kharif, 2015 and Kharif, 2016 at the Student Instructional Farm of C. S. Azad University of Agriculture and Technology, Kanpur (U.P.) to evaluate the effect of newer insecticides over natural enemies of paddy pests. The experiment was laid out in a Randomized Block Design (RBD) with seven treatments replicated thrice. The ruling rice variety Pusa Basmati-1 was transplanted in 5 × 4 m square meter plots with a spacing of 25 × 15 cm. The recommended dose of fertilizer of 120:40:40 kg / ha as N: P2O5: K2O was applied, respectively. About 25 per cent N and K2O and 100 per cent P2O5 were applied as basal and rest of N and K2O were applied in three equal split doses at tillering, panicle initiation and flowering stages. The details of the treatments were T1- Chlorantraniliprole 18.5% SC at 30 g a. i. / ha; T2- Imidacloprid 17.8 SL at 25 g a. i. / ha; T3- Buprofenzin 25 SC at 200 g a. i. / ha; T4- Cartaphydrachloride 4 G at 750 g a. i. / ha; T5- Malathion 5% Dust at 25 kg / ha; T6- Fipronil 5 SC at 75g a. i. / ha and T7- Control. Two sprayings were given at an interval of fifteen days. The insecticides were sprayed in their respective doses by diluting in sufficient amount of water (based on crop stage) with the help of Knapsack sprayer fitted with hollow cone nozzle. The incidence of natural enemies was recorded one day before of spray as pre-treatment observation and post treatment observations were taken at 3and 10 after spraying different times. The population of natural enemies was recorded at ten randomly selected hills leaving the border rows. The
Results and Discussion

Kharif, 2015

The results of the present investigation showed that the number of natural enemies among all treatments were non-significant before application of the insecticides which ranged from 8.37 to 10.01 No./5 sweeps, during Kharif, 2015 (Table-1). At three days after first spraying of insecticides, the incidence of natural enemies varied from 3.36 to 9.75 (No./5 sweeps), all the treatments were found effective and significantly superior over the untreated plots or control (9.75 no./5 sweeps). Except control plots, the maximum number 7.14 No./5 sweeps of natural enemies were found in chloreantraniliprole 18.5 SC treated plots followed by 6.31 No./5 sweeps in buprofezin 25 SC treated plots and the least number of natural enemies 3.36 No./5 sweeps was recorded in fipronil 5 SC treated plots. The result revealed that after ten days of first spraying the highest population of natural enemies 10.25 No./5 sweeps found in chloreantraniliprole treated plots followed by 6.88 chloreantraniliprole treated plots. The lowest population 2.76 No./5 sweeps was observed in fipronil 5 SC treated plots followed by 3.79 No./5 sweeps in malathion 5 D treated plots.

After the second foliar application of insecticides there was a decline in the number or population of natural enemies from three days after spraying and continued up to ten days after spraying. It was found that the highest population 10.25 No./5 sweeps of natural enemies was recorded in the untreated or checked plots followed by 6.88 and 6.02 No./5 sweeps in buprofezin SC and imidacloprid 17.8 SL treated plots, respectively. The lowest number 2.76 No./5 sweeps of natural enemies was observed in fipronil 5 SC treated plots followed by 3.79 No./5 sweeps in malathion treated plots.

Kharif, 2016

The number of natural enemies viz. spider, dragon fly, damsel fly and lady bird beetle (in the form of mean value), among all treatments were non-significant before application of the insecticides which ranged from 8.75 to 10.01 No./5 sweeps, during Kharif, 2016 (Table-2). The result of the present study showed that before the first foliar application of insecticides the population ranged from 3.31 to 9.71 No./5 sweeps at three days of spraying. The highest population 9.71 No./5 sweeps was in control plots followed by 7.12 and 6.25 No./5 sweeps in chloreantraniliprole 18.5 SC and buprofezin 25 SC treated plots, respectively. The minimum number 3.31 No./5 sweeps of natural enemies found in fipronil treated plots followed by 4.49 No./5 sweeps in malathion 5 D treated plots.

After ten days of second foliar application of insecticides all insecticides were responsible for reducing the population of natural enemies. The lowest number 1.96 No./5 sweeps of natural enemies was recorded in fipronil 5 SC treated plots followed by 3.17 and 3.83 No./5 sweeps in malathion 5 D and cartap hydrochloride 4 G treated plots, respectively. The highest movement of natural enemies was found in untreated plots (12.39 No./5 sweeps) followed by 4.83 No./5 sweeps in chloreantraniliprole 18.5 SC treated plots.

After ten days of first spraying the maximum number (10.22 No./5 sweeps) of natural enemies was found in untreated plots followed by 6.85, 6.05 and 5.81 No./5 sweeps in chloreantraniliprole 18.5 SC and buprofezin 25 SC treated plots, respectively. The least number
(2.84 No./5 sweeps) of natural enemies observed in fipronil 5 SC treated plots.

After second foliar spray of insecticides the observations were recorded after three and ten days of spraying. The highest population (11.43 No./5 sweeps) was found in control plots followed by 5.37 and 5.04 No./5 sweeps in chloreantraniliprole 18.5 SC and buprofezin 25 SC treated plots after three days of spraying, respectively. The lower populations (2.46 and 3.49 No./5 sweeps) of natural enemies were observed in fipronil 5 SC and malathion 5% D treated plots, respectively.

After ten days of second foliar spray of insecticides the least number (1.97 No./5 sweeps) of natural enemies was found in fipronil 5 SC treated plots followed by malathion 5% D treated plots with (3.19 No./5 sweeps) of natural enemies. The maximum number (12.21 No./5 sweeps) of natural enemies was found in control plots followed by 4.81 and 4.41 No./5 sweeps in chloreantraniliprole 18.5 SC and buprofezin 25 SC treated plots.

Kharif, 2015 & 2016 (Pooled)

Pooled data of both the experimental year (kharif, 2015 & 2016) showed that the 1st application of insecticides was done, when the insect-pests infestation reached at its ETL. The effect of insecticides on natural enemies was seen in the rice crop.

The population of natural enemies before the first foliar application of insecticides ranged from 8.56 to 9.95 No./5 sweeps. After the first insecticidal application, there was a decline in the natural enemies’ population.

The maximum number (9.73 No./5 sweeps) of natural enemies was recorded in untreated plots followed by 7.130 and 6.280 No./5 sweeps in chloreantraniliprole 18.5 SC and buprofezin 25 SC treated plots, respectively (Table-3). The fipronil 5 SC treated plots registered the lowest number 3.33 followed by malathion 5% D treated plots 4.49 No./5 sweeps of natural enemies.

After ten days of first insecticidal application chloreantraniliprole 18.5 SC was the most safer insecticide among all the insecticides with mean value 6.86 No./5 sweeps followed by buprofezin 25 SC with 6.037 No./5 sweeps. The fipronil 5 SC (2.80 No./5 sweeps) registered the worst performance in the survival of natural enemies among all the treatments followed by malathion 5% D (3.76 No./Sweeps).

The population of insect-pests was reduced with first spray. After some days an accidental increase was noticed in the crop therefore there was a need for second insecticidal spray. At three days of second spray the maximum population of natural enemies (10.97 No./5 sweeps) was recorded in control plots. All treatments were significantly effective except untreated plots. Chloreantraniliprole 18.5 SC treated plots registered the maximum mean value 5.35 No./5 sweeps of natural enemies followed by buprifezin 25 SC with 5.03 No./5 sweeps.

The lowest number (2.44 No./5 sweeps) was observed in fipronil 5 SC treated plots followed by malathion 5% D with mean value 3.50 of No./5 sweeps. After ten days of second insecticidal application the lowest number (1.96 No./5 sweeps) of natural enemies was observed in fipronil 5 SC treated plots followed by malathion 5% D and cartap hydrochloride 4 G with mean value 3.81 and 3.84 No./5 sweeps, respectively. The higher number 12.30 and 4.82 No./5 sweeps was recorded in untreated and chloreantraniliprole 18.5 SC, respectively.
### Table 1 Insecticidal effect on natural enemies Khrif, 2015

| Sr. No. | Treatment           | Doses (g. ai/ha) | Pretreatment | First Spray 3 Days | First Spray 10 Days | Second Spray 3 Days | Second Spray 10 Days |
|---------|---------------------|------------------|--------------|-------------------|-------------------|-------------------|-------------------|
| 1       | Chlorantraniliprole 18.5 SC | 30               | 8.75 (3.11)  | 7.14 (2.84)       | 6.88 (2.80)       | 6.88 (2.50)       | 4.83 (2.39)       |
| 2       | Buprofezin 25 SC    | 200              | 9.1 (3.14)   | 6.31 (2.68)       | 6.02 (2.62)       | 6.02 (2.44)       | 4.48 (2.34)       |
| 3       | Imidacloprid 17.8 SL | 25               | 8.37 (3.03)  | 6.12 (2.66)       | 5.87 (2.60)       | 5.87 (2.25)       | 3.98 (2.21)       |
| 4       | Fipronil 5 SC       | 75               | 9.96 (3.28)  | 3.36 (2.08)       | 2.76 (1.92)       | 2.76 (1.83)       | 1.96 (1.70)       |
| 5       | Cartaphhloride 4 G  | 750              | 9.37 (3.19)  | 5.37 (2.50)       | 4.97 (2.43)       | 4.97 (2.28)       | 3.83 (2.18)       |
| 6       | Malathion 5 D       | 25 kg            | 10.01 (3.29) | 4.49 (2.31)       | 3.79 (2.16)       | 3.79 (2.10)       | 3.17 (2.03)       |
| 7       | CONTROL             | -                | 9.31 (3.19)  | 9.75 (3.25)       | 10.25 (3.27)      | 10.25 (3.35)      | 12.39 (3.64)      |

**SEm**

| **SEm** | **1.272** | **1.411** | **1.388** | **1.119** | **1.184** |

**CD**

| **CD** | **NS** | **NS** | **4.325** | **3.485** | **3.689** |

[Figures within parentheses are square root \( \sqrt{x + 0.5} \) transformed values]
**Table.2** Insecticidal effect on natural enemies *Khrif*, 2016

| Sr. No. | Treatment               | Doses (g. ai/ha) | Pretreatment | First Spray | Second Spray |
|---------|-------------------------|------------------|--------------|-------------|--------------|
|         |                         |                  |              | 3 Days 10 Days | 3 Days 10 Days |
|         |                         |                  |              |             |              |
| 1       | Chlorantraniliprole 18.5 SC | 30               | 8.8 (3.12)   | 7.12 (2.83) | 6.85 (2.79)  | 5.37 (2.51) | 4.81 (2.39) |
| 2       | Buprofezin 25 SC         | 200              | 9.96 (3.28)  | 6.25 (2.66) | 6.05 (2.62)  | 5.04 (2.44) | 4.41 (2.32) |
| 3       | Imidacloprid 17.8 SL    | 25               | 8.75 (3.09)  | 6.08 (2.65) | 5.81 (2.59)  | 4.15 (2.25) | 3.93 (2.20) |
| 4       | Fipronil 5 SC           | 75               | 8.89 (3.13)  | 3.31 (2.07) | 2.84 (1.94)  | 2.46 (1.83) | 1.97 (1.71) |
| 5       | Cartaphhloride 4 G      | 750              | 9.02 (3.141) | 5.38 (2.50) | 4.9 (2.41)   | 4.31 (2.29) | 3.86 (2.19) |
| 6       | Malathion 5 D           | 25 kg            | 9.9 (3.28)   | 4.44 (2.31) | 3.73 (2.14)  | 3.49 (2.10) | 3.19 (2.04) |
| 7       | CONTROL                 | -                | 10.01 (3.29) | 9.71 (3.24) | 10.22 (3.32) | 11.43 (3.50) | 12.21 (3.61) |
| SEM±    |                         |                  | 1.146        | 1.409       | 1.373        | 1.112        | 1.236        |
| CD      |                         |                  | NS           | NS          | 4.279        | 3.498        | 3.850        |

Figures within parentheses are square root $\sqrt{x + 0.5}$ transformed values.
### Table 3: Insecticidal effect on natural enemies Pooled (Khrif, 2015 & 2016)

| S. No. | Treatment                        | Doses (g. ai/ha) | Pretreatment | First Spray | Second Spray |
|--------|----------------------------------|------------------|--------------|-------------|--------------|
|        |                                  |                  | 3 Days       | 10 Days     | 3 Days       | 10 Days     |
| 1      | Chlorantraniliprole 18.5 SC      | 30               | 8.777        | 7.130       | 6.867    | 5.353       | 4.823       |
|        |                                  |                  | (3.12)       | (2.84)      | (2.80)   | (2.51)      | (2.39)      |
| 2      | Buprofezin 25 SC                 | 200              | 9.533        | 6.280       | 6.037    | 5.033       | 4.443       |
|        |                                  |                  | (3.21)       | (2.67)      | (2.62)   | (2.44)      | (2.330)     |
| 3      | Imidacloprid 17.8 SL             | 25               | 8.563        | 6.100       | 5.840    | 4.163       | 3.953       |
|        |                                  |                  | (3.06)       | (2.65)      | (2.60)   | (2.25)      | (2.21)      |
| 4      | Fipronil 5 SC                    | 75               | 9.423        | 3.337       | 2.800    | 2.443       | 1.963       |
|        |                                  |                  | (3.21)       | (2.07)      | (1.93)   | (1.83)      | (1.71)      |
| 5      | Cartaphchloride 4 G              | 750              | 9.197        | 5.373       | 4.940    | 4.290       | 3.843       |
|        |                                  |                  | (3.17)       | (2.50)      | (2.42)   | (2.29)      | (2.18)      |
| 6      | Malathion 5 D                    | 25 kg            | 9.953        | 4.493       | 3.763    | 3.500       | 3.180       |
|        |                                  |                  | (3.28)       | (2.31)      | (2.10)   | (2.10)      | (2.03)      |
| 7      | CONTROL                          | -                | 9.660        | 9.733       | 10.237   | 10.917      | 12.300      |
|        |                                  |                  | (3.24)       | (3.33)      | (3.43)   | (3.43)      | (3.62)      |

**SEm+** 1.201 1.410 1.381 1.121 1.209

**CD** NS NS 4.302 3.493 3.767

Figures within parentheses are square root $\sqrt{x+0.5}$ transformed values.
The maximum number of natural enemies was recorded in chlorantraniliprole 18.5% SC treated plots except check (untreated or control) followed by buprofezin 25 SC, imidacloprid 17.8SL, cartap hydrochloride 4G, malatian 5% D and fipronil 5SC, respectively in both the experimental years. The findings of present studies are in conformity with results of Rao et al. (2006); Karthikeyan et al., (2007); Bastidas (1996); Tanaka et al., (2000); Ahmad et al., (2011); Ahmad et al., (2011) and Rodrigues et al., (2013). Bora et al., (2004) have also reported that population of predators, i.e. spiders, coccinellids, dragonflies and damselflies, was lowest in SBP (schedule-based pesticide application) and highest in NBC (natural biological control). The present finding supports neck to neck with the findings of Jaafar et al., (2013); Karthick et al., (2014) and Chatterjee et al., (2015) they reported the spider population was recorded maximum in the chlorantraniliprole 18.5 SC scheduled plots. Seni and Naik (2017) observed almost the same pattern of insecticidal effect on natural enemies in their experiment which also support the present finding.

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References

Ahmad, Munir; Rafiq, Muhammad; Arif, Muhammad; Iqbal Sayyedand Ali H. (2011). Toxicity of Some Commonly Used Insecticides Against Coccinella undecimpunctata (Coleoptera: Coccinellidae). Pakistan Journal of Zoology. 43(6): 1161-1165.

Anonymous (2017a). Agricultural Statistics at a Glance 2017, Department of Agriculture, Cooperation & Farmers Welfare, Directorate of Economics and Statistics Ministry of Agriculture & Farmers Welfare Government of India, pp-78.

Bacci, L. et al. (2007). Toxicity of insecticides to the sweet potato whitefly (Hemiptera: Aleyrodidae) and its natural enemies. Pest Management Science, 63, 699–706.

Bastidas, L.H. (1996). Effect of some insecticides on beneficial arthropods and populations of Tagosodesorizicolus (Muir) on rice crop. [Spanish] Efecto de algunosinsecticidassobreatropodosbe neficosy poblaciones de Tagosodesorizicolus (Muir) en el cultivodelarroz. Arroz [Journal article]. 45(402):9-17.

Bora, D. K., Bhuyan, U., Katti, G. and Pasalu, I. C. (2004). Quantification of insect pest and natural enemy incidence vis a vis yield. Uttar Pradesh Journal of Zoology, 24(2):187-190.

Chatterjee, Sitesh, Gangopadhyay, Chirasree and Roy, S. K. (2015). Management of rice insects by granular formulation of chlorantraniliprole along with foliar spray of some new molecules. The Journal Of Plant Protection Science, 7(1-2):6-13.

Fogel, M. N., Schneider, M. I., Desneux, N., González, B. and Ronco, A. E. (2013). Impact of the neonicotinoid acetamiprid on immature stages of the predator Eriopis connexa (Coleoptera: Coccinellidae). Ecotoxicology, 22, 1063–1071.

Gallagher, K.D., Kenmore, P.E. and K. Sogawa (1994). Judicial use of
Insecticides deter plant hopper out breaks and extend the life of resistant varieties in Southeast Asian rice. In Planthoppers: Their Ecology and Management (R.F. Denno and T.J. Perfect eds.). Chapman & Hall, New York, pp. 599-614.

Greathead, D. J (1995). Natural enemies in combination with pesticides for integrated pest management. In Reuveni, R. ed Novel Approaches to Integrated Pest Management Lewis Publishers, Boca Raton, FL, USA 183–197.

Hafeez, A.; Khan, R.B.; Sharma, D.; Jamwal, V.V.S. and Gupta, S. (2010). Seasonal incidence, infestation and trap catches of Cnaphalocrocis medinalis (Guenee) in Rice. Annals of Plant Protection Sciences, 18 (2): 380 – 383.

Heinrichs, E. A.; Aquino, S.; Chelliah, S.; Velencia, S.L. and Ressig W.H. (1982a). Resurgence of Nilaparvata lugens (Stal) populations as induced by method and timing of insecticide applications in low land rice. Environ. Entomol., 11: 78-84.

Ito, Y. K. Miyashita and K. Sekiguchi (1962). Studies on the predators of the rice crop insect-pests, using the insecticide check method. Jpn. J. Ecol., 12: 1-12.

Jaafar W. N. W.; Mazlan N.; Adam N.A. and Omar, D. (2013). Evaluation on the Effects of Insecticides on Biodiversity of Arthropod in Rice Ecosystem. Acta Biologica Malaysia, 2(3): 115-123.

Karthick, K. S.; Kandibane, M. and Kumar, K. (2014). Safety of newer insecticides to natural enemies in the coastal rice ecosystem of Karaikal, U.T. of Puducherry. JBiopest, 7(2):195-198.

Karthikeyan, K.; Jacob, S. and Purushothaman, S.M.(2007). Effectiveness of Cartap hydrochloride against rice stem borer and leaf folder and its safety to natural enemies. Journal of Biological Control, 21 (1) : 145-148.

Kiritani, K. (1979). Pest management in rice Annu. Rev. Entomol., 24 : 279-312.

Preetha, G., Stanley, J., Suresh, S. & Samiyappan, R. (2010). Risk assessment of insecticides used in rice on miridbug, Cytorhinus lividipennis Reuter, the important predator of brown planthopper, Nilaparvata lugens (Stal). Chemosphere, 80, 498–503.

Rao, N. B. V. C., Singh, V. S. and Chander, S. (2006). Effect of various combinations on rice leaf folder and its coleopteran predators. Journal of Entomological Research, 30(3): 219-223.

Rodrigues, E.N.L.; Mendonca Junior; M. de S.Fritz; L.L.Heinrichs, E.; A. Fiuza, L. (2013). Effect of the insecticide lambda-cyhalothrin on rice spider populations in southern Brazil. Zoologia [Journal article]., 30(6):615-622.

Seni, Atanu and Naik, Bhima Sen (2017) Efficacy of some insecticides against major insect pests of rice, Oryza sativa (L.). Journal of Entomology and Zoology Studies, 5(4): 1381-1385.
of rice planthoppers: Spiders, mired bug and dryinid wasp. *Applied Entomology Zoology*, 35(1):177-187.

Toyoda, K. and S. Yoshimura (1966). A study on the natural enemies of insect-pests in paddy field. II. Effect of various insecticides on the spiders in paddy field. *Res. Rep. Fukuoka Agric. Exp. Stn.*, 4: 52-59 (in Japanies).

Toyoda, K. and S. Yoshimura (1967). A study on the natural enemies of insect-pests in paddy field. III. Fluctuation of population of spiders and homopterous insect-pests after dusting with different kind of insecticides. *Res. Rep. Fukuoka Agric. Exp. Stn.*, 5: 58-73 (in Japanese).

Wang, H. Y. et al. Assessment of the impact of insecticides on *Anagrus nilaparvatae* (Pang et Wang) (Hymenoprera: Mymanidae), an egg parasitoid of the rice planthopper, *Nilaparvata lugens* (Hemiptera: Delphacidae). *Crop Prot.*, 27, 514–522 (2008).

Wang, Y. H. *et al.*, (2012). Susceptibility of adult *Trichogramma nubilale* (Hymenoptera: Trichogrammatidae) to selected insecticides with different modes of action. *Crop Protection*, 34, 76–82.

Wright, D. J. & Verkert, R. H. J. Integration of chemical and biological control systems for arthropods; evaluation in a multitrophic context. *Pest Manage. Sci.*, 44, 207–218 (1995).

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