Journal homepage:https://www.environcj.in/

Environment Conservation Journal

ISSN 0972-3099 (Print) 2278-5124 (Online)

Impact and selectivity of insecticides on groundnut predators

Burjikindi Madhuri✉

Department of Entomology, Professor Jayashankar Telangana state Agricultural University, Hyd- (Telangana), India

Rohini Sugandi

Department of Entomology, Institute of Organic farming, University of Agricultural Sciences, Dharwad (Karnataka), India

Subhash B. Kandakoor

Department of Agril. Entomology, University of Agricultural Sciences, Dharwad (Karnataka), India

B. S. Yenagi

Department of Agronomy, AICRP on Groundnut, Main Agricultural Research Station, University of Agricultural Sciences, Dharwad (Karnataka), India

Kolli Bharghavi

Department of Entomology, Professor Jayashankar Telangana state Agricultural University, Hyd- (Telangana), India

ARTICLE INFO

Received : 18 November 2023
Revised : 07 February 2024
Accepted : 16 February 2024

Available online: 02 March 2024

Key Words:
Coccinellids
Foliar spray
Seed treatment
Spiders
Summer

ABSTRACT

Predatory arthropods play a crucial role in mitigating the impact of insect pests. However, the use of broad-spectrum insecticides in pest management methods can pose a threat to predator populations. In response to the need for safer and more selective insecticides that spare natural enemies, an effort was made to know the diversity of predatory fauna and effect of seed dressers and foliar spraying insecticides on coccinellids and spiders at the Main Agricultural Research Station in Dharwad, Karnataka, during the summer 2021 and 2022. The treatments included four seed treatments, four seed treatments in combination with foliar spray, two foliar sprays alone, and an untreated control. Predator numbers were recorded at 45 and 65 days after sowing (DAS), selecting 20 plants randomly in all treatments. The results demonstrated that during the summer 2021 and 2022, seed treatment with chlorpyriphos 20EC was identified as safe, exhibiting the highest number of coccinellids (0.55 and 1.33 per plant) and spiders (0.54 and 1.62 per plant), respectively. These results were statistically comparable to other treatments like, seed treatment with imidacloprid 60 FS (0.49 and 1.00 coccinellids per plant) (0.48 and 1.38 spiders per plant), thiamethoxam 30 FS (0.45 and 0.95 coccinellids per plant) (0.44 and 1.22 spiders per plant) during 2021 and 2022 summer, respectively, ranking just below the untreated control. A significant difference in the population of coccinellids and spiders was observed among all the treatments, with seed-treated plants recording the highest predatory populations compared to foliar-sprayed plants. Consequently, the study concludes that seed treatment chemicals prove to be safer for predators while still effectively providing necessary pest control. This highlights the potential of integrating such seed treatment methods into pest management strategies to enhance overall efficacy while minimizing adverse effects on beneficial predator populations.

Introduction

Most agroecosystems host arthropod generalist predators that are crucial for controlling various pest populations (Sunderland *et al*., 1997; Symondson *et al*., 2002). Certain predators possess the ability to regulate herbivore populations, playing a vital role in keeping insect pests below a certain threshold. In the dynamic context of agricultural ecosystems, the delicate balance between pest management and the preservation of beneficial organisms is a crucial determinant of sustainable crop production. Groundnut, also known as peanut (*Arachis hypogaea*), is a significant global crop that contributes substantially to both food and oil production. However, groundnut cultivation faces

Corresponding author E-mail: madhuriburjikindi2016@gmail.com
Doi:https://doi.org/10.36953/ECJ.26202756

challenges from numerous insect pests that can compromise yield and quality. To address these challenges, the use of insecticides has become common for mitigating the impact of pests. However, the ecological consequences of insecticide application, particularly their impact on nontarget organisms such as groundnut predators, remain subjects of intense scrutiny and concern. Groundnut predators play a pivotal role in natural pest control by acting as natural buffers against harmful insect populations. These predators, including a diverse array of organisms such as predatory insects, spiders, and other beneficial arthropods, act as natural adversaries to pest populations, significantly contributing to overall pest control strategies. Understanding the intricate dynamics between insecticides and these predators is essential for devising sustainable pest management strategies that minimize collateral damage to beneficial organisms. Gurr *et al.* (2012) stated that a more diverse predator population results in predators that eat a variety of prey species, sizes, and life stages or that occupy distinct microhabitats on the ground surface or plant canopy. In comparison to a community with lower biodiversity, this diversity leads to a more successful suppression of herbivores. Wide-spectrum pesticide use in agroecosystems usually leads to a decrease in the number of predators (Ohnesorg *et al.*, 2009; Varenhorst and O'Neal, 2012), which may cause more insect outbreaks later in the growing season (Gross and Rosenheim, 2011). When new pests multiply in a field that has been sprayed, the use of such insecticides may drastically diminish the arthropod community as a whole, reducing the choices for biological management. Predators colonize areas more slowly and reproduce at a relatively modest rate, which exacerbates the problem. Predators can be preserved, and the recurrence of primary and secondary pests can be avoided by using more targeted insecticides and seed treatment techniques (Ruberson and Greenstone, 1998). This study aimed to explore the nuanced interactions between insecticides and groundnut predators by evaluating both the direct and indirect effects of their application in agricultural settings. By examining the selectivity of commonly employed insecticides, we sought to elucidate the intricate relationships governing the delicate equilibrium between pest control and the preservation of essential groundnut allies. Through a comprehensive exploration of these dynamics, we aspire to contribute valuable insights to the ongoing discourse on sustainable and environmentally conscious agricultural practices, fostering the harmonious coexistence of crop protection and biodiversity conservation.

Materials and Methods

The experiment was conducted at the Main Agricultural Research Station in Dharwad, Karnataka, during the summers of 2021 and 2022. The variety TAG-24 was used, and the gross plot size was 5 m × 4 m. Groundnut crops were sown with a row-to-row distance of 30 cm and a plant-to-plant distance of 10 cm under protective irrigation. Ten insecticide treatments and one untreated control were included in the RBD, and each treatment was replicated three times.

The evaluated insecticides included the following: Seed treatment with imidacloprid at 18.5% + hexaconazole at 1.50% FS (2 g/kg), seed treatment with thiamethoxam at 30 FS (2 ml/kg), seed treatment with imidacloprid at 60 FS (2 ml/kg), seed treatment with chlorpyriphos at 20EC (12 ml/kg), seed treatment with imidacloprid at 18.5% + hexaconazole at 1.50% FS + foliar spray with acetamiprid at 20% SP (2 g/kg + 0.25 g/L) at 45 and 55 DAS (DAS), seed treatment with thiamethoxam at 30 FS + foliar spray with acetamiprid at 20% SP (2 ml/kg + 0.25 g/L) at 45 and 55 DAS, seed treatment with imidacloprid at 60 FS + foliar spray with acetamiprid at 20% SP (2 ml/kg + 0.25 g/L) at 45 and 55 DAS, seed treatment with chlorpyriphos at 20EC + foliar spray with acetamiprid at 20% SP (12 ml/kg + 0.25 g/L) at 45 and 55 DAS, foliar spray with acetamiprid at 20% SP (0.25 g/L) at 25, 35, 45 and 55 DAS, Foliar spray with dimethoate at 25, 35, 45 and 55 DAS and treated control.

The groundnut seeds were treated with the specified quantity of insecticide in 100 ml of water at the time of sowing. Predator counts were recorded at 45 and 65 days after sowing (DAS) from 20 randomly selected plants in all treatments, and the means were calculated for further analysis.

Statistical analysis Data pertaining to spiders and coccinellids were quantified as the total number per plant and subsequently transformed to $\sqrt{X + 0.5}$ values prior to statistical analysis.

Results and discussion

Spiders and coccinellids recorded in the groundnut ecosystem are shown in Figure 1. Our study on the impact and selectivity of insecticides on groundnut predators provides crucial insights into integrated pest management in groundnut cultivation. As we examine the implications of insecticide application, a nuanced understanding of ecological dynamics becomes imperative for designing sustainable pest control strategies. Ladybird beetles and spiders were monitored at 45 and 65 DAS, revealing significant differences in their populations among treatments. Compared with the foliage-sprayed plots, the untreated control plots exhibited the highest predator populations, followed by the plots treated with only seeds (Table 1, Fig. 2).

Coccinellids: A greater population (0.55 and 1.33 coccinellids/plant) of coccinellids was observed in the seed-treated plots next to the untreated control plots (0.65 and 2.00 coccinellids/plant) in the summers of 2021 and 2022, respectively (Table 1, Fig. 2). Among the treatments, the maximum number of coccinellids was found in the seeds treatment with chlorpyriphos 20EC, i.e., 0.55 and 1.33 coccinellids per plant in the summers of 2021 and 2022, respectively. This count was statistically on par with that of seeds treated with imidacloprid 60 FS (0.49 and 1.00), thiamethoxam 30 FS (0.45 and 0.95), imidacloprid 18.5% + hexaconazole 1.50% FS (0.41 and 0.96), and chlorpyriphos 20EC + foliar spray with acetamiprid 20% SP (0.27 and 0.98) coccinellids per plant during the summers of 2021 and 2022, respectively (Table 1, Fig. 2). This suggests that predator activity is safer in seed-treated plots than in foliar-sprayed plots. Moreover, lower mean coccinellid populations were observed in foliar-sprayed plots and plots with a combination of seed treatment and foliar sprays than in the untreated control plots. These findings align with earlier studies by Satpute *et al.* (2001), Bhosale *et al.* (2009), and Patwari (2019), confirming that chlorpyriphos 20EC consistently recorded numerically higher populations of natural enemies. Kannan *et al.* (2004) reported that imidacloprid not only was safe but also attracted predators such as ladybird beetles. Importantly, the results revealed no significant reduction in the coccinellid population due to the application of insecticides as a seed treatment, confirming their safety.

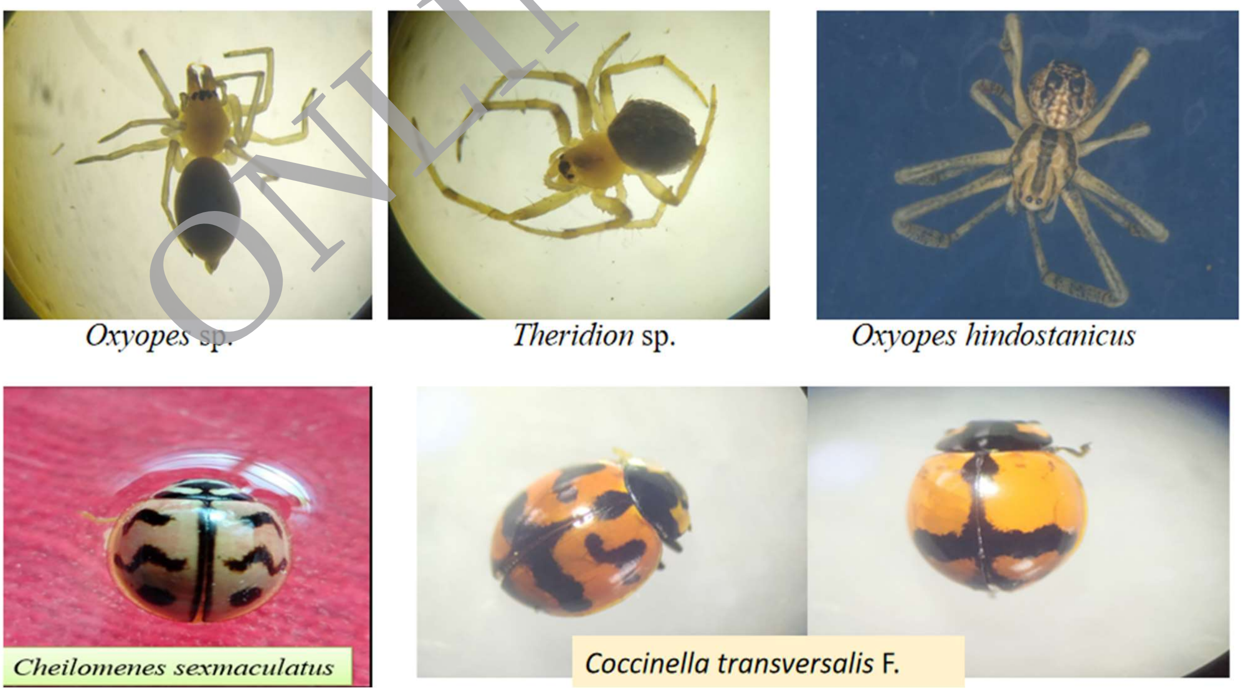

Figure 1: Spiders and coccinellids recorded in the groundnut ecosystem

Table 1: Impact of insecticides on groundnut predators during summer 2021

Sl. No.	Treatments	No. of Coccinellids/plant			No. of Spiders/plant		
		45 DAS	65 DAS	Mean	45 DAS	65 DAS	Mean
T_1	Seed treatment with Imidacloprid 18.5% +Hexaconazole 1.50% FS	0.12 $(0.79)^{bcd}$	0.70 $(1.08)^{a}$	0.41 $(0.95)^{abc}$	0.13 $(0.79)^{cd}$	0.68 $(1.08)^{a}$	0.41 $(0.94)^{abc}$
T_2	Seed treatment with Thiamethoxam 30 FS	0.17 $(0.82)^{bcd}$	0.72 $(1.09)^{a}$	0.45 $(0.96)^{abc}$	0.17 $(0.82)^{bcd}$	0.70 $(1.09)^{a}$	0.44 $(0.95)^{abc}$
T_3	Seed treatment with Imidacloprid 60 FS	0.22 $(0.84)^{bcd}$	0.75 $(1.10)^{a}$	0.49 $(0.98)^{ab}$	0.24 $(0.86)^{bc}$	0.72 $(1.10)^{a}$	0.48 $(0.98)^{ab}$
T_4	Seed treatment with Chlorpyriphos 20EC	0.30 $(0.88)^{abc}$	0.80 $(1.13)^{a}$	0.55 $(1.00)^{a}$	0.32 $(0.90)^{ab}$	0.75 $(1.10)^{a}$	0.54 $(1.00)^{a}$
T_5	T_1 + foliar spray with Acetamiprid 20% SP at 45, 55 DAS	0.12 $(0.79)^{bcd}$	0.05 $(0.74)^{b}$	0.09 $(0.76)^{d}$	0.12 $(0.79)^{cd}$	0.01 $(0.71)^{b}$	0.07 $(0.75)^{d}$
T_6	T_2 + foliar spray with Acetamiprid 20% SP at 45, 55 DAS	0.17 $(0.81)^{bcd}$	0.09 $(0.77)^{b}$	0.13 $(0.79)^{cd}$	0.16 $(0.81)^{bcd}$	0.03 $(0.73)^{b}$	0.10 $(0.77)^{d}$
T_7	T_3 + foliar spray with Acetamiprid 20% SP at 45, 55 DAS	0.21 $(0.84)^{bcd}$	0.11 $(0.78)^{b}$	0.16 $(0.81)^{bcd}$	0.24 $(0.85)^{bc}$	0.03 $(0.73)^{b}$	0.14 $(0.79)^{cd}$
T_8	T_4 + foliar spray with Acetamiprid 20% SP at 45, 55 DAS	0.32 $(0.89)^{ab}$	0.22 $(0.85)^{b}$	0.27 $(0.87)^{abcd}$	0.34 $(0.91)^{ab}$	0.08 $(0.76)^{b}$	0.21 $(0.84)^{bcd}$
T_9	Foliar spray with Acetamiprid 20% SP at 25, 35, 45, 55 DAS	0.05 $(0.74)^{e}$	0.01 $(0.71)^{b}$	0.03 $(0.73)^{d}$	0.05 $(0.74)^{d}$	0.01 $(0.71)^{b}$	0.03 $(0.73)^{d}$
T_{10}	Foliar spray with Dimethoate 30 EC at 25, 35, 45, 55 DAS (Standard check)	0.10 $(0.77)^{cd}$	0.06 $(0.75)^{b}$	0.08 $(0.76)^{d}$	0.08 $(0.76)^{cd}$	0.02 $(0.72)^{b}$	0.05 $(0.77)^{d}$
T_{11}	Untreated control	0.45 $(0.97)^{a}$	0.85 $(1.16)^{a}$	0.65 $(1.05)^{a}$	0.45 $(0.97)^{a}$	0.75 $(1.10)^{a}$	0.60 $(1.04)^{a}$
	S.Em. ±	0.04	0.06	0.06	0.04	0.06	0.06
	C.D. (5%)	0.10	0.17	0.17	0.11	0.18	0.17
	C.V. (%)	7.25	10.71	11.68	7.39	11.71	11.53

DAS- days after sowing. The figures in parentheses are square root ($\sqrt{x+0.5}$) transformed values, and the means with similar letters do not differ significantly according to dmrt (p=0.05).

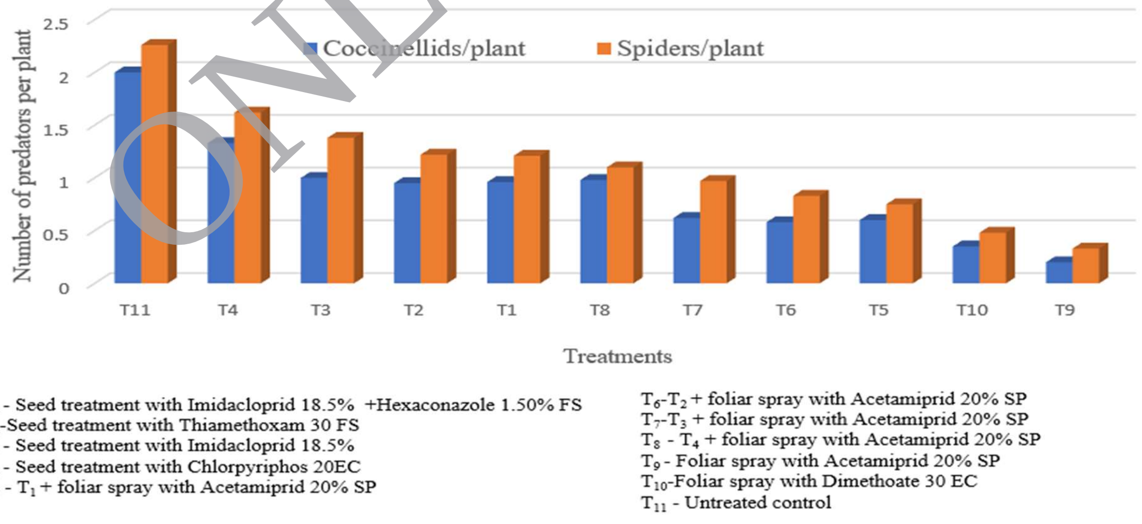

Figure 2: Average predator population recorded in different groundnut treatments during the summer of 2022

Spiders: A greater population (0.54 and 1.62 spiders per plant) of spiders was observed in the seed-treated plots next to the untreated control plots (0.60 and 2.26 spiders/plant) in the summers of 2021 and 2022, respectively (Table 1, Fig. 2). Among the treatments, seed treatment with chlorpyriphos 20EC was found to be safe, with the highest number of spiders recorded, 0.54 and 1.62 spiders per plant in the summers of 2021 and 2022, respectively. This count was statistically on par with that of seeds treated with imidacloprid 60 FS (0.48 and 1.38), thiamethoxam 30 FS (0.44 and 1.22), and imidacloprid 18.5% + hexaconazole 1.50% FS (0.41 and 1.21) spiders per plant during the summers of 2021 and 2022, respectively (Table 1, Fig. 2). These results indicate that spider mites are safer in seed-treated plots than in foliar-sprayed plots and plots with a combination of seed treatment and foliar sprays. These findings align with earlier studies by Satpute *et al.* (2001), Bhosale *et al*. (2009), Patwari (2019), and Swarupa *et al*. (2019), confirming that chlorpyriphos 20EC consistently recorded numerically higher populations of natural enemies. Satpute *et al.* (2001) reported that imidacloprid is safe for natural enemies. Importantly, the results revealed no significant reduction in the spider population due to the application of insecticides as a seed treatment. These findings contrast with those of Swarupa *et al*. (2019), who reported that the least safe insecticides for seed treatment were imidacloprid 60 FS (86.27 & 80.56%) and thiamethoxam 35 FS (84.31 & 75.00%), which resulted in a decrease of more than 50% in the spider population. A key observation from our research is the variable response of groundnut predators to different classes of insecticides. Some chemicals exhibit high selectivity, targeting pest species with minimal impact on beneficial predators, while others show a broader spectrum of activity, affecting both target and nontarget organisms. This underscores the importance of carefully choosing insecticides based on their ecological impact. This study emphasizes the pivotal role of groundnut predators, such as ladybird beetles, lacewings, and spiders, in regulating pest populations within agroecosystems. Predatory insects significantly contribute to the natural suppression of pest numbers, and any disturbance to their populations due to insecticide exposure could disrupt the delicate balance between pests and their natural enemies. Furthermore, our research highlights the need for a comprehensive understanding of the life cycle and behavior of groundnut predators. The different life stages of these beneficial organisms may exhibit varying susceptibilities to insecticides, necessitating a more targeted approach for pesticide application. Integrating this knowledge into pest management strategies can enhance the overall effectiveness of control measures while minimizing unintended consequences for nontarget species. Additionally, the emergence of insecticide resistance in pest populations is a growing concern in modern agriculture. Our study suggested that continuous and indiscriminate use of certain insecticides may contribute to the development of resistance, rendering them less effective over time. This emphasizes the importance of adopting integrated pest management practices that include rotating insecticides, utilizing biological control agents, and implementing cultural practices to mitigate resistance issues.

Conclusion
Our investigation into the impact and selectivity of insecticides on groundnut predators emphasizes the intricate interplay between pest control strategies and the conservation of beneficial organisms. According to the preceding discussion, seed dressing chemicals are relatively safer and can be integrated into future pest management programs in which natural biocontrol agents play an important role. Nevertheless, our investigation also substantiated the apparent deleterious qualitative and quantitative effects of foliar spraying of insecticides on predator populations. When recommending pesticide sprays, the level of activity and potential of natural predatory and parasitoid insects should be considered. The insights gained from this study contribute to the ongoing dialog on refining pest management practices, advocating for a holistic approach that prioritizes both productivity and environmental stewardship in groundnut cultivation.

Acknowledgments
We are grateful to the Department of Agricultural Entomology, AICRP on Groundnut (UASD) and

University of Agricultural Sciences, Dharwad, for their unwavering support throughout the research.

Conflict of interest
The authors declare that they have no conflicts of interest.

References
Bhosale, B. B., Agale, D. A. & Kadam, D. R. (2009). Bioefficacy of different insecticides against thrips in Bt cotton. *Pestology,* 33(9), 26-28.

Gross, K. & Rosenheim, J. A. (2011). Quantifying secondary pest outbreaks in cotton and their monetary cost with causal-inference statistics. *Ecological Applications*, 21(7), 2770–2780.

Gurr, G. M., Wratten, S. D. & Snyder, W. E. (Eds.). (2012). *Biodiversity and insect pests: key issues for sustainable management*. John Wiley & Sons.

Kannan, M., Uthamasamy, S. & Mohan, S. (2004). Impact of insecticides on sucking pests and natural enemy complex of transgenic cotton. *Current Science*, 86(5), 726-729.

Ohnesorg, W. J., Johnson, K. D. & O'neal, M. E. (2009). Impact of reduced-risk insecticides on soybean aphid and associated natural enemies. *Journal of economic entomology*, *102*(5), 1816-1826.

Patwari, A. B., (2019). Management of sucking insect-pests infesting groundnut. M.Sc. (Agri.) Thesis submitted to Vasantrao naik marathwada krishi vidyapeeth, Parbhani, India, p. 51.

Ruberson, J. R. & Greenstone, M. H. (1998). Predators of budworm/bollworm eggs in cotton: an immunological study. In *Proc. Beltwide Cotton Conf* (Vol. 2).

Satpute, N. S., Katole, S. R., Nimbalkar, S. A., Sarnaik, D. N. & Satpute, U. S. (2001). Efficacy of imidacloprid and thiamethoxam as seed treatment against cotton jassids, *Amrasca devastans* Distant. *Journal of applied zoological researches,* 12(1), 88- 90.

Sunderland, K. D., Axelsen, J. A., Dromph, K., Freier, B. & Hemptinne, J. L. (1997). Pest control by a community of natural enemies. *Acta Jutlandica*, 72, 271–326.

Swarupa, Y., Elanchezhyan, K., Allwin, L., Aananthi, N. & Srinivasan, M. R. (2019). Efficacy of insecticide seed treatments against sucking pests and natural enemies in cowpea, *Vigna unguiculata* (Linn.) Walpers. *Journal of Pharmacognosy and Phytochemistry*, *8*(3), 3982-3989.

Symondson, W. O. C., Sunderland, K. D. & Greenstone, M. H. (2002). Can generalist predators be effective biocontrol agents? *Annual review of entomology*, *47*(1), 561-594.

Varenhorst, A. J. & O'Neal, M. E. (2012). The response of natural enemies to selective insecticides applied to soybean. *Environmental entomology*, *41*(6), 1565-1574.

Publisher's Note: The ASEA remains neutral with regard to jurisdictional claims in published maps and figures.