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COMPARATIVE TOXICITY OF COMMONLY USED INSECTICIDES TO AGROBIONT SPIDERS IN *BT* COTTON

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ABSTRACT

The study was conducted at Agricultural Research Station, Anand Agricultural University, Sansoli (Gujarat) during *kharif* season of 2024 to evaluate comparative toxicity of commonly used insecticides to agrobiont spiders in *Bt* cotton. Among the different seven insecticides evaluated, spinetoram 11.70 SC, flonicamid 50 WG and chloratraniliprole 9.3 + lambda-cyhalotrin 4.5 ZC were found safer in terms of toxicity by recording higher spider population. Profenophos 40 + cypermethrin 4 EC, thiamethoxam 12.6 + lambda-cyhalotrin 9.5 ZC, acephate 75 SP and imidacloprid 17.8 SL were found comparatively less safe than other insecticides evaluated under study. During the observation period, more exuviae of spiders found in treated plots which indicate that it could be used as protective or curative measure by spider between spray application periods.

***Keywords* :** *Bt* cotton, comparative toxicity, insecticides, spiders.

Introduction

Spiders (Phylum: Arthropoda, Class: Arachnida, and Order: Araneae) are arthropods that are considered the largest order of arachnids. The word spider comes from the Latin word “spinnen,” meaning to spin (Siliwal *et al.*, 2005). In India, a total of 1992 species (6504 genera) belonging to 62 families have been recorded (Anonymous, 2024). A total of 266 species belonging to 89 genera of 28 families are recorded from Gujarat (Siliwal *et al*., 2003).

Most terrestrial environments are known to be inhabited by spiders. Because they can hunt a wider variety of insect pests, they are generalist predators. Spiders of several families are commonly found in agro-ecosystems and have been documented as general predators of major crop pest species (Geetha and Gopalan, 1999). The merit of the generalist predators comes from the fact that they have the highest host-finding ability and capacity to consume a greater number of preys than other field-inhabiting predators (Kamal *et al*., 1990) and can survive on alternate insect pests when the density of the major pests becomes low. Among the most common and varied groups of organisms are these. The fact that different spiders have different hunting tactics, preferred habitats, and times of activity may make them useful for biological control. Spiders exhibit both functional and numerical responses to prey densities. As an ideal bio-control agent, spiders show tolerance and sometimes even resistance against pesticides in the agricultural field (Sarma *et al*., 2013).

The total reliance on chemical pesticides for pest suppression has taken its toll severely on health and the environment (Kaaya, 1994). The pesticide spray not only kills the pests, but it simultaneously affects the non-target invertebrates like spiders. Agricultural fields that are frequently sprayed with pesticides often have lower spider populations (Amalin *et al.*, 2001). Generally, spiders are more susceptible to the effects of pesticide compounds compared to many other pests for certain pesticides, including sulphur, carbamates, carbaryl, organophosphates, and synthetic pyrethroids. Pest populations may become out of control if spider populations decline due to pesticide use. Understanding how chemical pesticides affect spider populations would therefore lead to a wider acceptance of Integrated Pest management (IPM) and conservation biological management. There are 162 insect pests present in cotton crops at different stages, of which roughly 15 are regarded as possible crop hazards (Kannan *et al*., 2004). The cotton crop requires an intensive use of pesticides to manage the various pests that cause extensive damage. Over the past 40 years, many pests have developed resistance against pesticides (Reddy *et al*., 2009). In recent years, extensive use of chemicals has raised environmental and health problems. Thus, the present study was conducted to evaluate the comparative toxicity of commonly used insecticides to the spider population in the *Bt* cotton ecosystem.

Materials and Methods

To evaluate comparative toxicity of commonly used insecticides to agrobiont spiders in *Bt* cotton the field experiments were carried out at Agricultural Research Station, Anand Agricultural University, Sansoli (Gujarat) during July, 2024 in a Randomized Complete Block Design with a cotton crop (BG II Cotton Hybrid) replicated thrice and having a gross plot size of 4.8 x 6.0 m². All the standard agronomical practices have been followed. A single spray application of below mentioned different seven insecticides was applied at the appearance of spiders in crop at its respective dose with the help of knapsack sprayer.

Treatments	Conc. (%)	Dose	
		g a.i./ha	g or mL/10 litre water
Thiamethoxam 12.6 + lambda-cyhalothrin 9.5 ZC	0.009	45	4.00
Spinetoram 11.7 SC	0.01	50	9.00
Chlorantraniliprole 9.3 + lambda-cyhalothrin 4.6 ZC	0.008	40	6.00
Profenophos 40 + cypermethrin 4 EC	0.09	450	20.00
Imidacloprid 17.8 SL	0.004	20	2.00
Flonicamid 50 WG	0.015	75	3.00
Acephate 75 SP	0.116	584	16.00
Control	-	-	-

The population of spiders was recorded from five randomly selected plants through visual inspection one day before and 3, 7, 14 and 21 days after insecticidal spray. The data obtained thus, were subjected to statistical analysis after appropriate transformation to draw valid conclusion as per Steel and Torrie (1980).

Results and Discussion

The periodical data on population of agrobiont spiders before and after 3, 7, 14 and 21 days after spray (DAS) and pooled over periods of spray results are presented in Table 1 and Figure 1. The agrobiont spiders' population was found homogenous in all the treatments before spray as treatment difference was found non-significant.

3rd DAS

The results presented in Table 1 revealed that all the insecticides used in the field experiment altered the spider population. Third day after spraying, spiders' population recorded significantly lower in all the treated plots over untreated check. Among all the insecticides evaluated, comparatively higher spider population observed in spinetoram 11.7 SC (1.87 spiders/plant) which was found at par with flonicamid 50 WG (1.78 spiders/plant) and chloratraniliprole 9.3+ lambda-cyhalothrin 4.5 ZC (1.72 spiders/plant) and proved as safer for spider than rest of the insecticides under study. Whereas comparatively lower population of spiders were observed in imidacloprid 17.8 SL (1.04 spiders/plant) followed by acephate 75 SP (1.11 spiders/plant), profenophos 40 + cypermethrin 4 EC (1.11 spiders/plant) and thiamethoxam 12.6 + lambda-cyhalothrin 9.5 ZC had (1.14 spiders/plant).

7th DAS

The results after seventh day of spray indicated that there was slight increase in spiders' population in all the treatments (Table 1). Of the evaluated insecticides, the higher increase in spider population observed in spinetoram 11.7 SC (2.16 spiders/plant) which found at par with flonicamid 50 WG (2.06 spiders/plant) and chloratraniliprole 9.3 + lambda-cyhalothrin 4.5 ZC (1.96 spiders/plant) which were found safer for spider population, whereas comparatively lower population of spider were observed in imidacloprid 17.8 SL (1.16 spiders/plant), acephate 75 SP (1.22 spiders/plant), thiamethoxam 12.6 + lambda-cyhalothrin 9.5 ZC (1.27 spiders/plant) and profenophos 40 + cypermethrin 4 EC (1.30 spiders/plant) and proved as less safer insecticides to spiders under study. The increase in spider population has been observed due to immigration by ballooning or migration from neighbouring field margin.

Table 1: Comparative toxicity of different insecticides to population of spiders in *Bt* cotton (*Kharif*, 2024-25)

Treatments	Conc. (%)	No. of spiders/plant at indicated days after spray					
		Before spray	3	7	14	21	Pooled over periods
Thiomethoxam 12.60%+lambda-cyhalothrin 9.5% ZC	0.009	1.89 (3.07)	1.28[c] (1.14)	1.33[c] (1.27)	1.37[c] (1.38)	1.57[c] (1.96)	1.39[c] (1.43)
Spinetoram 11.70% SC	0.01	1.83 (2.85)	1.54[b] (1.87)	1.63[b] (2.16)	1.68[b] (2.32)	1.87[a] (3.00)	1.68[b] (2.32)
Chloratraniliprole 9.3% + lambda-cyhalothrin 4.5% ZC	0.008	1.93 (3.22)	1.49[b] (1.72)	1.57[b] (1.96)	1.64[b] (2.19)	1.79[b] (2.70)	1.62[b] (2.12)
Profenophos 40% + cypermethrin 4% EC	0.09	1.78 (2.67)	1.27[c] (1.11)	1.34[c] (1.30)	1.39[c] (1.43)	1.58[c] (2.00)	1.39[c] (1.43)
Imidacloprid 17.80% SL	0.004	1.79 (2.70)	1.24[c] (1.04)	1.29[c] (1.16)	1.32[c] (1.24)	1.53[c] (1.84)	1.34[c] (1.30)
Flonicamid 50% WG	0.015	1.87 (3.00)	1.51[b] (1.78)	1.60[b] (2.06)	1.66[b] (2.26)	1.87[a] (3.00)	1.66[b] (2.26)
Acephate 75% SP	0.116	1.86 (2.96)	1.27[c] (1.11)	1.31[c] (1.22)	1.34[c] (1.30)	1.55[c] (1.90)	1.37[c] (1.38)
Control	-	1.82 (2.81)	1.84[a] (2.89)	1.87[a] (3.00)	1.91[a] (3.15)	1.92[a] (3.19)	1.88[a] (3.03)
S. Em. ± Treatment(T)		0.11	0.07	0.07	0.07	0.09	0.04
Period (P)		-	-	-	-	-	0.03
T x P		-	-	-	-	-	0.08
f test		NS	Sig.	Sig.	Sig.	Sig.	Sig.
C.V. (%)		10.59	8.19	8.39	8.31	9.24	8.48

Notes: 1. Figures in parentheses are retransformed values; those outside are $\sqrt{(x+0.5)}$ transformed values.
2. Treatment means with the letter(s) in common are not differing significantly by Duncan's New Multiple Range Test (DNMRT) at 5% level of significance.
3. Significant parameters and its interactions: P

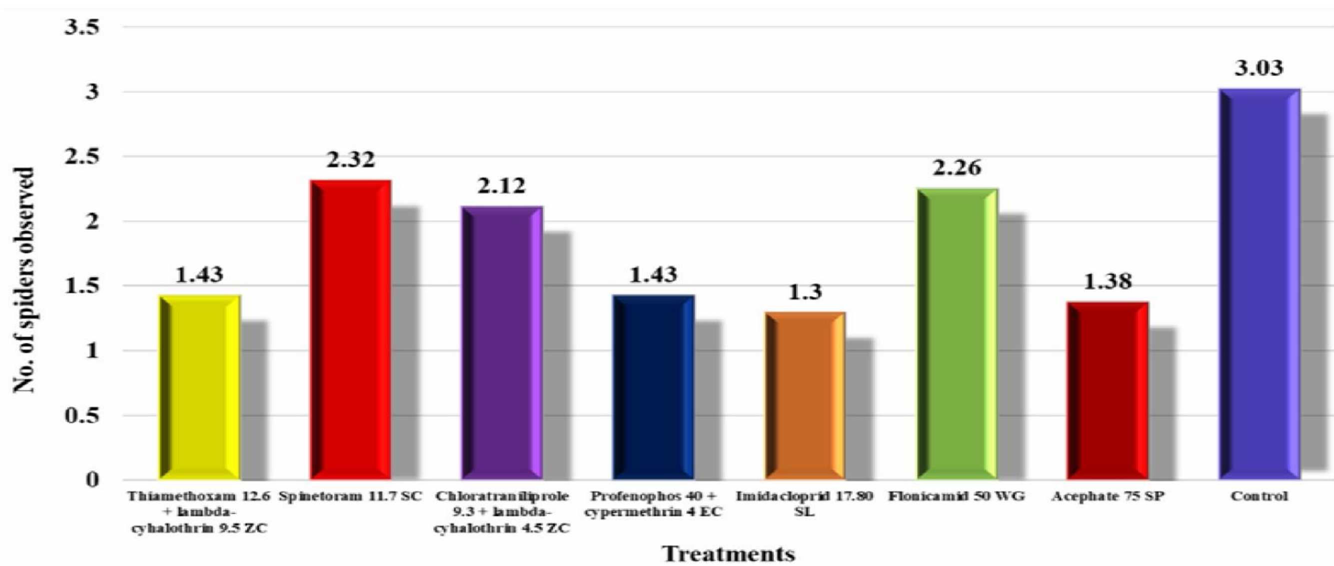

Fig.1: Comparative toxicity of different insecticides on population of spiders in *Bt* cotton

14th DAS

The data on fourteen days after spraying, indicated that the increased number of spiders in all the treatments (Table 1). The significantly higher spider population was observed in spinetoram 11.7 SC (2.32 spiders/plant) which found at par with flonicamid 50 WG (2.26 spiders/plant) and chloratraniliprole 9.3 + lambda cyhalothrin 4.5 ZC (2.19 spiders/plant) shows these insecticides had lest effect on spiders over other evaluated insecticides. Whereas comparatively lower population of spiders were observed in imidacloprid 17.8 SL (1.24 spiders/plant), acephate 75 SP (1.30 spiders/plant), thiamethoxam 12.6 + lambda-cyhalothrin 9.5 ZC (1.38 spiders/plant) and profenophos 40 + cypermethrin 4 EC (1.43 spiders/ plant).

21st DAS

Twenty-one days after spraying, there was further increasing trend observed in spiders' population in all the treatments (Table 1). The higher spider population was observed in spinetoram 11.7 SC (3.00 spiders/plant) which found at par with flonicamid 50 WG (3.00 spiders/plant) and chloratraniliprole 9.3 + lambda cyhalothrin 4.5 ZC (2.70 spiders/plant) shows the least toxicity of insecticide toward the spiders. Whereas comparatively lower population of spider were observed in imidacloprid 17.80 SL (1.84 spiders/plant), acephate 75 SP (1.90 spiders/plant), thiamethoxam 12.60 + lambda-cyhalothrin 9.5 ZC (1.96 spiders/plant) and profenophos 40 % + cypermethrin 4 EC (2.00 spiders/plant).

Pooled over periods

Data on pooled over periods presented in Table 1 indicated that all the evaluated insecticides were found to alter the spiders' population compared to control at 3, 7, 14 and 21 days after spray. Among all the insecticides evaluated, the higher spiders' population was observed in plots treated with spinetoram 11.7 SC (2.32 spiders/plant) which was at par with flonicamid 50 WG (2.26 spiders/plant) and chloratraniliprole 9.3 + lambda-cyhalothrin 4.5 ZC (2.12 spiders/plant) which shows the resulted as safer and comparatively less toxic to spider population. Whereas comparatively lower population of spider were observed imidacloprid 17.8 SL (1.30 spiders/plant), acephate 75 SP (1.38 spiders/plant), thiamethoxam 12.6 + lambda cyhalothrin 9.5 ZC (1.43 spiders/plant) and profenophos 40 + cypermethrin 4 EC (1.43 spiders/ plant) and proved as less safe insecticides as compared to other evaluated insecticides under study (Table 1).

In nutshell, the treatments of spinetoram 11.70 SC, flonicamid 50 WG and chloratraniliprole 9.3 + lambda-cyhalotrin 4.5 ZC were found safer in terms of toxicity by recording higher spider population. Profenophos 40 + cypermethrin 4 EC, thiamethoxam 12.6 + lambda-cyhalotrin 9.5 ZC, acephate 75 SP and imidacloprid 17.8 SL were more toxic compared to other insecticides.

Spiders are highly sensitive to different insecticides under field condition (Plate 1). In the present study, susceptibility of the agrobiont spider to different seven insecticides were investigated under field condition. Among the evaluated insecticides, comparatively lower spiders' population was observed in treatment of imidacloprid 17.8 SL which is more frequently used by farmers and effective insecticide in controlling sucking pests which are agrobiont spiders' diet that may be one of the reasons behind lower observed spider population in treated plots.

Moreover, the tendency of migration was observed in spider population toward the periphery of the experimental sides. It was observed that spiders tend to migrate during effects of spraying on field. That might be one of the reasons behind lower spider population in treated plots. Furthermore, during observation period more exuviae of spider found in treated plots which indicated that it could be used as protective or curative measure used by spider during spray period (Plate 1). The variation in toxicity level in different insecticides under study might be also due to a contact of spider with chemical pesticide could vary greatly being exposed to spray droplets or to residues on surface or to contaminated prey or all at the same time.

The present findings are in accordance with Divekar *et al*. (2020) who evaluated the comparative toxicity of different insecticides and found that all three doses of spinetoram 11.7 SC found safer than rest of the evaluated insecticides. Matcha *et al*. (2021) studied effect of some newer chemicals against *Spodoptera litura* (F.) on soybean and found that the highest spiders population recorded in treatments, chlorantraniliprole 18.5 SC @ 0.3 mL/L with 1.25 spiders/plant which was statistically at par with spinetoram 11.7 SC @ 0.5 mL/L. Kumari *et al*. (2019) who evaluated the toxicity of different biological and chemical insecticides on spiders in laboratory and revealed that among synthetic insecticides, imidacloprid 17.8 SL with 80 percent mortality, was more harmful as compared to chlorpyriphos 20 EC and cypermethrin 10% EC with 16.5 and 4.8 percent mortality, respectively. The present finding also support the experimental outcomes of Sherawat *et al*. (2015) who recorded the higher toxicity of imidacloprid 17.8 SL compared to Buctril-M to spiders.

Forced moulting to escape from insecticidal exposure

Dead spiders due to insecticidal exposure

Knockdown effect of insecticide on spider

Plate 1: Effects of insecticides on spiders in *Bt* Cotton

Conclusion

From the present investigations, it is concluded that spray application of insecticides altered the spider population in *Bt* cotton. Spinetoram 11.70 SC, flonicamid 50 WG and chloratraniliprole 9.3 + lambda-cyhalotrin 4.5 ZC were found safer in terms of toxicity by recording higher spider population. Profenophos 40 + cypermethrin 4 EC, thiamethoxam 12.6 + lambda-cyhalotrin 9.5 ZC, acephate 75 SP and imidacloprid 17.8 SL were found comparatively less safe than other insecticides evaluated under study. During the observation period, more exuviae of spiders found in treated plots which indicate that it could be used as protective or curative measure by spider between spray application periods.

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