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Effect of Pest Control Applications on Sorghum-Panicle Pests and Associated Predators at Sohag Governorate, Egypt

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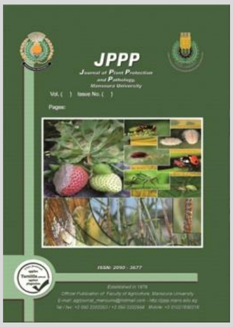

ABSTRACT

Sorghum panicles offer a very rich microenvironment for many insect pest species and their natural enemies. A field experiment was conducted on sorghum (*Sorghum bicolor* L.) variety "Shandaweel 6" in Shandaweel Research Station (SRS), Sohag Governorate, Egypt during the 2019 growing season. Lepidopteran and hemipteran pests were the most dominant species-infested sorghum panicles during the half bloom stage of the panicles. Three microlepidopteran pests, the noctuid, *Eublemma gayneri* (Roth.); the pyralid, *Cryptoblabes gnidiella* Millière, and the cosmopterigid, *Pyroderces simplex* Walsingham, were recorded as major pest species infesting sorghum panicles in Sohag Governorate. Four treatments; *B. bassiana*, Bt, *Thuja* extract and Lambada-cybalothrin pesticide were applied against sorghum panicle pests in general, and particularly against the mention microlepidopteran pests. Pesticide was recorded the highest reduction rates in the target pests (*E. gayneri, C. gnidiella* and *P. simplex*) with 68.48, 78.46, 80.41 and 81.55% respectively, these effects were significantly differed with the rest of the compounds except thuja extract against *C. gnidiella*, where the differences between the chemical pesticide and *B. bassiana* faded. also, in the non-target pests, pesticide was recorded the highest reduction rate of Aphid, Thrips and Hemipteran pests with 67.98, 75.95 and 57.11% respectively, and significant difference with the rest of the compounds was noted except *B. bassiana* in the case of Aphid and Hemipteran pests, where the differences between the chemical pesticide and *B. bassiana* faded.

Keywords: Sorghum, Panicle, Predators, Biopesticide, *B. bassiana* Bt, *Thuja* Extract.

INTRODUCTION

Sorghum, *S. bicolor* is one of the most important food and feed crops in the developing world; it ranks fourth in importance as a cereal crop after wheat, rice, and maize, and it is one of the most abiotic stress-tolerant summer grain crops. Sorghum is grown in Upper Egypt (89000 ha) located in Assiut and Sohag Governorates (Ezzat *et al*.,2010) and Sohag Governorate planted approximately 34% of the cultivated area in Egypt (FAO, 2012). Breeding programs are targeted at generating high-yielding and stable varieties or hybrids. Efforts are extended to expand the agricultural area in Upper Egypt by reclaiming desert regions (Hovny *et al*., 2000).

Of the more than 100 sorghum insect pests reported in Africa, 42 species were found to be panicle-feeding pests (Ratnadass &Ajayi, 1995). In the same context, Guo *et al*., (2011) mentioned that Sorghum is affected by about 150 insect species (in 29 families) all over the world causing a hazard to sorghum productivity which pests targeted seeds, seedlings, whorls, blooming structures, and mature grain at various phases of growth. A wide range of insect species attacks this crop from seedling emergence up to harvesting (Ajayi *et al.,* 2001, EI-Rawy, 2004, and El-Gepaly, 2007). However, pests of panicles took a little attention in Egypt (El-Rawey *et al.,* 2008 and El-Gepaly, 2019). Infestations with micro-earworms are not visible on super-facial examination, except on occasions, when a lot of waste is produced and pushed out of panicles (El-Gepaly, 2019). Panicles of sorghum offer suitable microenvironment for many pests specially microlepidoptera pests, which require smaller patches of habitat to survive than do butterflies or large moths. The developmental period of sorghum panicle lasts 35–55 days without shield offering a rich microenvironment that attracts many insects (Ratnadass and Butler 2003). larvae feed on the sorghum grains inside the panicle in the field from milky stage to maturity of the crop and result in considerable loss of yield (Knutson and Cronholm, 2007). Infestation with *E. gayneri, C. gnidiella* and *P. simplex* on sorghum panicles was recorded in Egypt by El-Rawy *et al*., (2008) and El-Gepaly (2019).

Studies on natural enemies associated with the sorghum panicles pests mostly focus on the macro-lepidopteran. rare studies have been concerned with their natural enemies of micro-lepidopteran pests (Walikar and Deshapande, 2011). Predators are usually found associated with sorghum field and could be play an important role in sorghum pests. In Egypt, anthocord predators, *Orius* spp., were discovered attacking mango inflorescence with the *E. gayneri* population (Abdel Kareim *et al*., 2018). Also, El-Gepaly (2019) recorded coccinellids, and *Orius* spp. were the dominant predators collected form panicles. Spiders as a generalist predator was recorded in maize field in Sohag,

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Egypt during survey (El-Gepaly *et al*., 2018) and the same author was recorded many spiders associated with panicle pests (El-Gepaly 2019). On the other side, parasitoids of microlepidopteran pests in sorghum plants have less attention, which only El-gepaly (2019) was recorded two parasitoids, *Nemorilla floralis* (Fallén, 1810) (Tachinidae: Diptera) and *Brachymeria aegyptiaca* (Chalcididae: Hymenoptera) on *E. gayneri.*

Although sorghum is the major staple cereal trap in Africa and Asia, the concept of sorghum pest control did not receive much attention until in the late 1960s and early 1970s when sorghum acreage rapidly expanded in the USA, then sorghum insect pest control was solely expanding (Passlow *et al.,* 1985).

Sorghum insect pests can be controlled with a variety pesticide (McLeod and Greene 2004). But, most farmers have not employed control measurement for these pests and sometimes chemical insecticides applied for suppressing both shoot fly and stem borers at the same time (Van den Berg and van Rensburg 1996, Kahate *et al*., 2014).Chemical control of sorghum pests may be maximized the environmental problems and collapse the biodiversity of insects especially natural enemies. Entomopathogens have been successfully tested against many species and some have been developed into commercial products causing a little environment impact. Biopesticides containing the fungus, *Beauveria bassiana*, reduced larval mortality in the rice moth, *Corcyra cephalonica*, lowering adult emergence and controlling several storage pests infesting sorghum grain (Kaur *et al*., 2014) and the bacterial formulations of *Bacillus thuringiensis* strain kurstaki as Delfin successfully decreased stem borer *C. partellus* damage on sorghum (Kumar *et al*., 2019)

This study focusses on the effect of four different components, *B. bassiana*, Bt, Thuja extract and Lambada-cybalothrinLambada-cybalothrin pesticide against microlepidoptera of sorghum panicle and the effect on non-target organisms included predators.

MATERIALS AND METHODS

Field experiment was carried out within the Department of Sorghum Research program that planted at Shandaweel Research Station (SRS), Sohag Governorate, Egypt during 2019 growing season on sorghum (*Sorghum bicolor* L.) variety "Shandaweel 6" that planted in 1stJuly 2019. The tested treatments were (1) the entomopathogenic/endophytic fungus, *B. bassiana* at dose of 2 gm witted mycelium/litter water, (2) commercial entomopathogenic bacteria (Protecto), *Bacillus thuringiensis* var. kurstaki WP 9.4% at dose of 1 gm/litter, (3) The seed extract of *Thuja oriantalis* at concentrate of 5% (4) The pesticide, Lambada-cybalothrin 5% EC at rate of 37.5 ml/fed/fad. And (5) control treatment (without treat).

Extract preparation: The collected leaves of *Thuja oriantalis* were dried for about 7 days in a shady room. After that, the dried samples were grinded and sieved by 40 meshes to give equal particle size. Using soxhlet extractor (Hot Continuous Extraction) with 70% methanol as organic solvent and followed the standard procedures as outlined by El-Gepaly, *et al*., (2016). A known amount of crude extract was dissolved in respective solvent in 1:1 proportion and serially diluted with water to obtain the target concentrations of 0.5%.

Preparation of fungus: The culture of the fungus was obtained from local isolate that breading in insect lab., SRS by Miss. Manal Barakat Omar which she prepares20 gm of witted mycelium and 20 ml of filtered media then, mixed with 10 litter water for spraying.

An area of about one feddan was designated for testing the effect of applying four treatments on pests and natural enemies. The field experiment was carried out in a complete randomized block design (CRBD), with three replicates for each treatment. Treatments were applied at soft dough stage at afternoon, where pre-application inspection and post-application inspection in the 1st, 3rd, 7th, 10thdays post application were recorded weekly by investigate nine panicles randomly selected in the three replicates for each treatment and lasting until the post-harvest.

In field: Samples were collected in two parts: first, each panicle was shaken separately in a white-plastic container (20 L), specimens were sorted according to the morphological specifications and saved in a suitable plastic tube with 70% ethyl alcohol for classification. Second part, the panicle was covered the panicle after shaking with a paper bag to hold all the arthropods until transferred to the laboratory for further examination. Also samples were taken after harvest**.**

In laboratory: For insect pests: Each panicle of the field samples was examined separately, the spiders and insects were separated and counted. Each similar group of whole insects except Lepidoptera pests was preserved together in 70% ethyl alcohol in tubes to be ready for identification. Weekly collected samples of lepidopteran panicles worms at any immature stage(larval and pupal stages) were kept in glass vials covered with muslin cloth throughout their developmental period with suitable food (a piece of sorghum panicle) until emergence of either the adults or the parasitoid. Emerging parasitoids were examined daily and preserved in tubes containing 70% ethyl alcohol for identification. Identification of all samples were carried out in surveying and classification Department, PPRI, ARC, Giza.

Statistical analysis: Percentage of mortality was calculated and the mortality in the control was corrected using Henderson-Tilton's formula (Henderson and Tilton, 1955), then, data was subjected to analysis of variance (ANOVA) and the means were separated using Least Significant Difference (LSD).

RESULTS AND DISCUSSION

1- Biodiversity of sorghum panicles:

Data in Table (1) illustrated the species that found during survey of pests and associated natural enemies of sorghum-panicles from flowering to the end of season. Data showed that eleven pest species belonged to sex orders that branched to ten families. Some pests were neglective which they were appear for once or twice with rare numbers used for identification. Data showed that *R. maidis*, *T. tabaci* and *P. simplex* were the most pests associated with panicle of sorghum by 5.79,4.75and 2.99

individuals/plant followed by two hemipteran pests, *C. pallidus* and *T. pallidulus*by 2.20 individuals/plant, while *E. gayneri* and *C. gnidiella* recorded 1.40 and 1.34 individuals/plant.

On the other hand, natural enemies were presented ten predator species belonged to four insect orders (that branched to five families) and four spider families. Some of them were in rare numbers. *Orius sp*., was the most frequencies predator which recorded 1.95individuals/panicle followed by spiders which was recorded 0.17individuals/plant. Also, *Ch. Carnea* and *Scymnus spp*. were shared by 0.06 and 0.01 individuals/panicle. Moreover, two parasitoids were survived during the study period, *Brachymeria minuta* Linn 1967 and *Brachymeria excrinata* Gahan 1925. Calculation of mean numbers of pest and predatorswere18.46 and 2.18 individuals/panicle as a mean incidence during all panicle stages

Table 1. Arthropod species diversity associated with sorghum panicles during 2019 season at Sohag Governorate, Egypt.

	Specie	Family: Order	Mean No. of sp./panicle	Total No. of spp/panicle	Status
1	*Carpophilus* sp. Stephens, 1830	Nitidulidae: Coleoptera	Neglective		Pest
2	*Sarcophaga carnaria* (Linnaeus, 1758)	Sarcophagidae: Diptera	Neglective		Pest
3	*Creontia despallidus* Distant, 1883	Miridae: Hemiptera	2.20		Pest
4	*Taylorilygus pallidulus* Blanchard	Miridae: Hemiptera			Pest
5	*Empoasca decipiens* Paoli, 1930	Cicadellidae: Homoptera	Neglective		Pest
6	*Rhopalosiphum maidis* Fitch, 1856	Aphididae: Homoptera	5.79	18.46	Pest
7	*Spodoptera littoralis* L.	Noctuidae: Lepidoptera	Neglective		Pest
8	*Eublemma gayneri* Hübner, 1829	Erebidae: Lepidoptera	1.40		Pest
9	*Cryptoblabes gnidiella* (Millière, 1867)	Pyralidae: Lepidoptera	1.34		Pest
10	*Pyroderces simplex* Walsingham, 1891	Cosmopterigidae: Lepidoptera	2.99		Pest
11	*Thrips tabaci* Lindeman, 1889	Thripidae: Thysanoptera	4.75		Pest
12	*Coccinella undecimpunctata* L. 1758	Coccinellidae: Coleoptera	Neglective		Predators
13	*Scymnus* spp. Kugelann, 1794	Coccinellidae: Coleoptera	0.01		Predators
14	*Paederus alfierii* Fabricius, 1775	Staphylinidae: Coleoptera	Neglective		Predators
15	*Sphaerophoria flavicauda Zett.*	Syrphidae: Diptera	Neglective		Predators
16	*Orius* sp. Wolff, 1811	Anthocoridae: Hemiptera	1.95	2.18	Predators
17	*Chrysoperla carnea* (Stephens, 1836)	Chrysopidae: Neuroptera	0.06		Predators
18	*Cheiracanthium isiacum* Koch, 1839	Miturgidae: Araneida			Predators
19	*Thanatus* sp. Koch in 1837	Philodromidae: Araneida	0.17		Predators
20	*Thyeneim perialis* (Rossi, 1846)	Salticidae: Araneida			Predators
21	*Thomisus spinifer* Cambridge 1872	Thomisidae: Araneida			Predators
22	*Brachymeria minuta* Linn 1967	Chalcididae: Hymenoptera	Neglective		Parasitoid
23	*Brachymeria excrinata* Gahan 1925	Chalcididae: Hymenoptera	Neglective		Parasitoid

The identified species have been monitored by previous authors with relative importance according to geographical location and environmental conditions (Salama *et al.,* 2004 a&b, El-Rawy *et al.,* 2008, El-Gepaly *et al.,* 2018, El-Gepaly 2019). In details, data general agree with El-Gepaly (2019) who found thirty Arthropoda species belonging to 28 families pertaining to 9 orders were obtained from sorghum-panicles, of those, 14 were pests, 16 species were predators, and 3 species were parasitoids. He also mentioned that lepidopteran and hemipteran pests were the most dominant pests infesting sorghum-panicles during mature stages. Also the number of earworms found in this study agree with Tomar (1989) who found the range of ear head worms to be 1.55 to 5.99/panicle. Gage (1990) recorded ear head worm infestation ranging from 1.00 to 5.00 per cob on sweet sorghum varieties, and no entry was free from damage.

2- Control application:

In this research, chemical and bio-pesticides have been taken on the pests of the sorghum crop in general, particularly lepidopteran pests of panicles, *C. gnidiella, E. gyneri* and *P. simplex*, using four treatments, *B. bassiana*, BT, extract and Lambada-cybalothrin pesticide. These treatments were applied on panicle on half bloom stage, which studied pests were present.

The results in Table (2) indicate the reduction rate achieved by the application of *B. bassiana,* BT, *Thuja* extract and pesticide against the non-target pests; Aphid, Thrips**,** and a mixture of Hemipteran insects

Data in Table (2) refer to the results of statistical analysis of reduction rates as a result of the use of 4 different compounds on some non-targeted pests that existed during data collection.These pests are Aphid, *Rohpalosiphum maids*, Thrips, *T. tabaci* and a mixture of Hemipteran insects, and it is clear from the data presented in Table (2) that there are no significant differences between the strength impact of the compounds used either for the direct effector the remaining effect or the overall average of the compound.

Pesticide was recorded the highest reduction rate of *Aphid*, *Thrips* and Hemipteran pests at 67.98, 75.95 and 57.11% respectively, by a significant difference with the rest of the compounds except *B. bassiana* in the case of Aphid and Hemipteran pests, where the differences between the chemical pesticide and *B. bassiana* was faded.

With regard to the interaction between compounds and the timing of the effect, the pesticide achieved the highest reduction rates, which resulted from 78.21, 64.57 and 61.16% for Aphid, as reduction rates of direct effect, residual effect, and the average effect of the pesticide respectively, and it is noted through the data presented in Table (2) that the direct effect and the residual effect of the *B. bassiana* was high and there were no significant differences between them and the effect of the pesticide. While the fungal and bacterial pesticide came at the end of the order in terms of effectiveness. As for *Thrips* the pesticide also achieved the highest reduction rates, which resulted from 85.11, 72.90 and 69.85 % as reduction rates of direct effect, residual effect, and the average effect of the pesticide respectively, and it is noted through the data presented in table1 that the direct effect and the residual effect of the *B. bassiana* was high and there were no significant differences between them and the effect of the pesticide. While the fungal and bacterial pesticide came at the end of the order in terms of effectiveness. As for Hemiptera the pesticide also achieved the highest reduction rates, which resulted from 80.48, 49.33 and 41.54 %as reduction rates of direct effect, residual effect, and the average effect of the pesticide respectively, and it is noted through the data presented in table1 that the direct effect and the residual effect of the plant extract was high and there were no significant differences between them and the effect of the pesticide, while the fungal and bacterial pesticide came at the end of the order in terms of effectiveness.

Table 2. Direct, residual, and mean effect of four components, *B. bassiana*, BT, EX and Lambada-cybalothrin pesticide on non-target pests in Maze plants during 2019 season at Sohag Governorate

		B. bassiana	BT	EX	Pesticide	Mean	LSD
Aphid	Direct Effect	22.44 H	35.76 e-h	71.86 Ab	78.21 A	52.07 A	
	Residual Effect	39.78 d-h	32.61 f-h	57.33 a-e	64.57 a-c	48.57 A	11.69
	Mean Effect	46.57 c-g	25.99 gh	53.69 b-f	61.16 a-d	46.85 A	
	Means	36.27 B	31.45 B	60.96 A	67.98 A	LSD for interaction	
	LSD		13.45			23.3	
Thrips	Direct Effect	25.46 D	14.44 de	61.82 Bc	85.11 A	46.71 A	
	Residual Effect	58.91 C	15.67 de	64.43 Bc	72.90 Ab	52.98 A	6.577
	Mean Effect	64.08 Bc	12.27 e	65.08 Bc	69.85 Bc	52.82 A	
	Means	49.48 C	14.13 D	63.78 B	75.95 A	13.15	
	LSD		7.595				
Hemiptera	Direct Effect	37.41 Cde	15.09 e	62.18 Ab	80.48 A	48.79 A	
	Residual Effect	44.06 Bcd	17.32 e	47.55 Bc	49.33 Bc	39.56 A	11.69
	Mean Effect	45.19 Bcd	21.89 de	43.90 Bcd	41.54 Bcd	38.13 A	
	Means	42.22 B	18.10 C	51.21 AB	57.11 A	23.37	
	LSD		13.49				

Application of Bt is not expected to affect the mentioned pests in Table (2) as the nature of their nutrition does not correspond to the nature of the infectious poison, which requires feeding directly to spores, but Babin *et al.,* (2020) Who studied the side effects of Bt compounds on non-target organisms *Drosophila* species present in Bt-treated areas, where he mentioned that high doses at$\geq$1000-fold of these compounds cause development alterations to *Drosophila* species. The result indicated that pesticide was the most effective application against aphid, thrips and complex of Hemiptera followed by *Thuja* extract, these results are partly consistent with the *Carlos et al.,* (2021) who have conducted a field study to record the efficacy of synthetic and botanical-derived insecticides against *Melanaphis sacchari*, and non-target and beneficial species associated with cultivated Sorghum in Mexico, they recorded that, the effect of components depends on several factors such as insect species, developmental stage, and exposure time to the products.

The data in Table (3) refers to the results of statistical analysis of reduction rates as a result of the use of 4 different compounds on microlepidoptera as a targeted pest, *E. gayneri, C. gnidiella, P. simplex*, and a mixture of Lepidoptera insects. Data in Table (3) cleared that, no significant differences were observed between the time of impact of the components used against *E. gayneri* and *C. gnidiella*, but reduction of *P. simplex* was significantly differed between time of impact, which reduction in the direct impact (28.78%) was increased significantly in residual effect (66.15%) and increased again significantly when calculating the average reduction (76.78%) where LSD= 8.8. the significant differences in *P. simplex* population were reflecting on total lepidopteran pests which reduction for direct impact was increased significantly also in total lepidoptera from46.51% to 68.88% in residual effect and insignificantly increased to record 74.11% in mean reduction (LSD= 6.62). on the other hand, Pesticide recorded the highest reduction rate of *E. gayneri, C. gnidiella, P. simplex,* and total Lepidoptera pests with 68.48, 78.46, 80.41 and 81.55% respectively, by a significant difference with the rest of the compounds except plant extract in the case of *C. gnidiella*, where the differences between the chemical pesticide and *B. bassiana* was faded. With regard to the interaction between compounds and time impact, the pesticide achieved the highest reduction rates, recording 78.48, 65.15 and 61.82% for *E. gayneri*, 87.35, 75.50 and 72.54% for *C. gnidiella*, 80.71, 80.31 and 80.21% for *P. simplex* and 86.03, 80.06 and 78.57% for total Lepidoptera pests as reduction rates of direct effect, residual effect, and the average effect respectively, where the rest of the interactions monitored in Table (3) ranged from insignificant to significant differences with the results of the pesticide reduction. For *E. gayneri*, the residual effect and mean effect of *B. bassiana* and BT were high and there were no significant differences between them and the effect of the pesticide (LSD= 38.2). While the *B. bassiana* came at the end of the order in terms of effectiveness. As for the *C. gnidiella* it is noted through the data presented in the Table (3) that only direct effect of *B. bassiana* and BT applications (37.08 and 34.3% respectively) have significant differences with pesticide application with LSD=33.04.As for *P. simplex*, data illustrated that direct effect of fungus, Bacteria and Extract was slightly observed by 11.96, 11.36 and 11.11% respectively, and came in last significant group with significant differences comparing with reduction of pesticide, but reduction in the same applications were increased dramatically to gain the same significant group of pesticide when calculated the mean reductions. Mean Effect and the residual effect of the BT was high and there were no significant differences between them and the effect of the pesticide and Mean Effect of *B. bassiana* was high and there were no significant differences between them and the effect of the pesticide. As for reduction in total lepidoptera, only BT in mean reduction (76.77%) was insignificant differ from the superior pesticide application. Direct effect of fungus and BT were recorded the lowest reduction with 27.07 and 28.7% respectively, in the same time no significant differences were observed in mean reduction.

The data in Table (3) refers to the results of statistical analysis of reduction rates as a result of the use of 4 different compounds on microlepidoptera as a targeted pest, *E. gayneri, C. gnidiella, P. simplex,* and a mixture of Lepidoptera insects. Data in Table (3) cleared that, no significant differences were observed between the time of impact of the components used against *E. gayneri* and *C. gnidiella*, but reduction of *P. simplex* was significantly differed between time of impact, which reduction in the direct impact (28.78%) was increased significantly in residual effect (66.15%) and increased again significantly when calculating the average reduction (76.78%) where LSD= 8.8. the significant differences in *P. simplex* population were reflecting on total lepidopteran pests which reduction for direct impact was increased significantly also in total lepidoptera from46.51% to 68.88% in residual effect and insignificantly increased to record 74.11% in mean reduction (LSD= 6.62). on the other hand, Pesticide recorded the highest reduction rate of *E. gayneri, C. gnidiella, P. simplex,* and total Lepidoptera pests with 68.48, 78.46, 80.41 and 81.55% respectively, by a significant difference with the rest of the compounds except plant extract in the case of *C. gnidiella,* where the differences between the chemical pesticide and *B. bassiana* was faded. With regard to the interaction between compounds and time impact, the pesticide achieved the highest reduction rates, recording 78.48, 65.15 and 61.82% for *E. gayneri*, 87.35, 75.50 and 72.54% for *C. gnidiella*, 80.71, 80.31 and 80.21% for *P. simplex* and 86.03, 80.06 and 78.57% for total Lepidoptera pests as reduction rates of direct effect, residual effect, and the average effect respectively, where the rest of the interactions monitored in Table (3) ranged from insignificant to significant differences with the results of the pesticide reduction. For *E. gayneri,* the residual effect and mean effect of *B. bassiana* and BT were high and there were no significant differences between them and the effect of the pesticide (LSD= 38.2). While the *B. bassiana* came at the end of the order in terms of effectiveness. As for the *C. gnidiella* it is noted through the data presented in the Table (3) that only direct effect of *B. bassiana* and BT applications (37.08 and 34.3% respectively) have significant differences with pesticide application with LSD=33.04.As for *P. simplex,* data illustrated that direct effect of fungus, Bacteria and Extract was slightly observed by 11.96, 11.36 and 11.11% respectively, and came in last significant group with significant differences comparing with reduction of pesticide, but reduction in the same applications were increased dramatically to gain the same significant group of pesticide when calculated the mean reductions. Mean Effect and the residual effect of the BT was high and there were no significant differences between them and the effect of the pesticide and Mean Effect of *B. bassiana* was high and there were no significant differences between them and the effect of the pesticide. As for reduction in total lepidoptera, only BT in mean reduction (76.77%) was insignificant differ from the superior pesticide application. Direct effect of fungus and BT were recorded the lowest reduction with 27.07 and 28.7% respectively, in the same time no significant differences were observed in mean reduction.

Table 3. Direct, residual, and mean effect of four components, *B. bassiana*, BT, EX and Lambada-cybalothrin pesticide on target pests in Maze plants during 2019 season at Sohag Governorate

		B. bassiana	BT	EX	Pesticide	Mean	LSD
E. gayneri	Direct Effect	13.77 E	18.94 de	23.74 c-e	78.48 A	33.73 A	
	Residual Effect	53.28 a-d	49.65 a-e	34.63 b-e	65.15 Ab	50.68 A	19.1
	Mean Effect	57.10 a-d	52.00 a-d	37.35 b-e	61.82 a-c	52.07 A	
	Means	41.38 B	40.20 B	31.90 B	68.48 A		38.2
	LSD			22.05			
C. gnidiella	Direct Effect	37.08 Cd	34.30 d	60.83 Abcd	87.35 A	54.89 A	
	Residual Effect	52.55 b-d	54.80 a-d	66.41 a-d	75.50 Ab	62.31 A	16.52
	Mean Effect	64.73 a-d	64.11 a-d	67.80 a-c	72.54 Ab	67.29 A	
	Means	51.45 B	51.07 B	65.01 AB	78.46 A		33.04
	LSD			19.07			
P. simplex	Direct Effect	11.96 D	11.36 d	11.11D	80.71A	28.78 C	
	Residual Effect	60.50 C	63.05 bc	60.74 C	80.31 Ab	66.15 B	8.8
	Mean Effect	73.27 a-c	80.51 ab	73.14 a-c	80.21 Ab	76.78 A	
	Means	48.58 B	51.64 B	48.33 B	80.41 A		17.6
	LSD			10.16			
Lepidoptera	Direct Effect	27.07 F	28.70 f	44.23 E	86.03 A	46.51 B	
	Residual Effect	64.43 D	65.02 d	66.02 Cd	80.06 Ab	68.88 A	6.623
	Mean Effect	69.66 b-d	76.77 a-d	71.47 b-d	78.57 a-c	74.11 A	
	Means	53.72 B	56.83 B	60.57 B	81.55 A		13.25
	LSD			7.648			

This result indicated that pesticide was the most effective component have reduced on panicle pests including microlepidopteran pests in direct effect, on the other hand biopesticides have reduced those microlepidopteran larvae without significant differences with chemical pesticide in residual and mean effect. This finding can be discussed though application control of stemborer in maize or sorghum. The results agree in general with the finding of Kumar *et al*., (2019) who indicated that, commercial formulations of Btk successfully decreased stem borer *C. partellus* damage on sorghum. Also the results reassemble with Lewis *et al*., (1996) who explained that *B. bassiana* can grow endophytically within maize plants and reduce borer damage added a new dimension to the use of fungal entomopathogens against stem borers. *B. bassiana* has been used experimentally to suppress populations of *O. nubilalis* on maize for many years (Bing and Lewis, 1991), Similarly, Maniania (1993) reports a reduction in damage due to *C. partellus* on maize in Kenya following application of *B. bassiana*

Table (4) shows the effect of using four compounds, *B. bassiana,* BT, EX and pesticide on different predators, where the data generally indicate the significant differences between the use of the pesticide and the rest of the compounds where the pesticide recorded a reduction in the number of predators by 76.58% with significant differences with the closest compounds to it, the plant extract, which recorded 61.48% at LSD=12.54. on the other hand, direct effect of all components was the most harmful for predators which reduced 69.38% of population, this impact was influenced by time as the reduction rate is significantly lower when calculating the residual effect and the mean reduction which reached 56.09 and 52.94% respectively. The results in Table (4) indicate the effect of interaction between the compounds used and the time of the effect, the highest effect received by predators was in the case of the use of pesticide and *B. bassiana* after the first day of use where the pesticide recorded a reduction rate of 94.51% and significant differ with all interactions except the direct effect of *B. bassiana*, which recorded a reduction of 80.96%. It is also clear from the data in Table (4) that fungicides and bacterial pesticides were the least affected on predators without significant differences between them and between the residual effect and the mean reduction of plant extract as well as between the mean reduction of the pesticide (LSD= 21.72).

Table 4. Direct, residual, and mean effect of four components, *B. bassiana*, BT, EX and Lambada-cybalothrin pesticide on Total Predators in Maze plants during 2019 season at Sohag Governorate

Total Predators	*B. bassiana*	BT	EX	Pesticide	Mean	LSD
Direct Effect	55.15 Cd	46.88 d	80.96 Ab	94.51 A	71.08A	
Residual Effect	48.98 Cd	49.79 cd	54.99 Cd	70.60 Bc	56.09 AB	19.19
Mean Effect	45.23 D	53.42 cd	48.50 D	64.63 b-d	52.95 AB	
Means	45.23 BCD	53.42 BC	48.50 BCD	64.63 ABC	21.72	
LSD		15.66				

These results agree with the finding of Thungrabeab and Tongma (2007) who studied The effect of entomopathogenic fungi, *B. bassiana* and *Metarhizium anisopliae* on non-target insects, such as natural enemies, *C. septempunctata*, *Ch. carnea* and *Dicyphus tamaninii* they were recorded mortality daily till the next generation and showed that *B. bassiana* was found to be non-pathogenic to natural enemies and beneficial soil insect. These results were supported also by Broza *et al.* (2001) and Vestergaard and Dromph (2002), who noted that *B. bassiana*, did not affect the mortalities of three collembolan species, *Folsomia fimetaria* L.

RECOMMENDATION

Further study is needed to determine the optimal time for one early application in combination with one late application, with the former being applied at different times after crop emergence.

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تأثير تطبيق مكافحة الآفات علي آفات كيزان الذرة الرفيعة والمفترسات المصاحبة في محافظة سوهاج

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تمثل كيزان الذرة الرفيعة بيئة غنية للعديد من الآفات والأعداء الطبيعية والتى استهدفتها هذه الدراسة فى محطة بحوث شنويل بسوهاج خلال موسم النمو ٢٠١٩ حيث تم اجراء دراسة حقلية لحصر الأنواع المتواجدة. وأشارت النتائج تفوق تعداد الحشرات حرشفية ونصفية الأجنحة خلال مرحلة الأزهار. وكانت أهم الأنواع حرشفية الأجنحة التى تصيب الكيزان هى: *Eublemma gayneri* و *Cryptoblabes gnidiella* و *Pyroderces simplex*. كذلك تم تطبيق معاملات مكافحة ضد الآفات بشكل عام وخاصة الآفات حرشفية الأجنحة بإستخام اربع معاملات: فطر *B. bassiana* - بكتريا Bt - مستخلص Thuja ومبيد Lambada-cybalothrin. وقد سجل المبيد الكيماوى أعلى معدل خفض فى تعداد الآفات المستهفة باختلاف معنوى عن بقية المعاملات ماعدا المستخلص ضد *C. gnidiella*. أيضا تلاشت الفروق المعنوية بين المبيد الكيميائي والفطر في الآفات غير المستهدفة (من ـ تربس ـ نصفية الاجنحة ـ مفترسات).