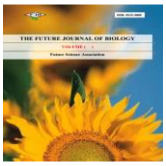

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Differential Feeding Parameters of *Spodoptera littoralis* on Beet Type Leaves treated with Insecticides

Suzan M. S. Badr*, Samy K. M. Korish, Heba A. B. Soliman and Suzan, A. I. Ali

Plant Protection Research Institute, Agricultural Research Center, Dokki, Giza, Egypt.

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***Corresponding author:** suzanbadr20@gmail,com

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Abstract: Cotton leafworm, *Spodoptera littoralis* (Boisd.) is a major lepidopteran pest of beet types in Egypt. The present investigation was conducted to determine the effect of three beet types; sugar, table and fodder beet on feeding *S. littoralis* in addition to the toxic effects of three insecticides, Protecto 9.4% WP (*Bacillus thuringiensis*), Speedo 5.7 % WG (emamectin benzoate) and winsor 24% SC (methoxyfenozide) under semi-field conditions. This study was carried out in 2023 and 2024 seasons, at Sakha Agricultural Research Station. Results revealed that the lowest area of the leaf consumed by *S. littoralis* after 24 h was significantly recorded in both fodder and sugar beet type treatments; it was 1.10 and 1.29 cm^2 /larva, respectively. Feeding percentage rate of 4^{th} instar *S. littoralis* larvae fed on different beet leaves treated with Protecto, Winsor and Speedo at 1/2 and 1 field rates was decreased. At 1/2 recommended rate after 24 h, the lowest area of the consumed leaf and feeding percentage were significantly recorded in Speedo treatment on table beet 0.59 cm^2/ larva and 2.99%, respectively. Based on the nutritional values of testing beet types, results proved that table beet was the most favorable type for *S. littoralis* due to the differences in the leaf nutritional quality and low level of total phenol in the leaves of table beet. This research aims to determine the most effective and sustainable method for controlling *S. littoralis* by comparing the tolerance of different beet types with the efficacy of various insecticides.

Key words: *Spodoptera littoralis*, beet types, feeding deterrence, toxicity, insecticides.

1. Introduction

Beet**,** *Beta vulgaris* is a globally significant crop cultivated for commercial sugar, forage, natural dyes, and human food consumption. Also, its extracts are used as natural food colorants and possess potent antioxidant properties, which have been shown to reduce lipid oxidation in cooked pork **(Mornement, 2002)**. The vegetable's high antioxidant capacity is attributed to its phenolic compounds, which offer nutraceutical benefits by promoting human health and preventing degenerative diseases and cancer **(Yang *et al.*, 2008)**. More than its nutritional value, sugar beet is a cornerstone of the sugar industry, agriculture, and various related sectors, supporting economic growth and sustainable farming practices **(El-Fergani, 2019)**. Table beet and fodder beet are also valuable crops, with fodder beet providing a particularly high yield potential for feeding ruminants and pigs **(Anonymous, 2006 and Henry, 2010)**. Insects represent one of the most significant threats to plant survival due to their abundance and diversity **(Erb and Reymond, 2019)**. Cotton leafworm, *Spodoptera littoralis* (Boisd.) (Lepidoptera: Noctuidae), poses a major threat to beet crops in Egypt. This highly destructive pest infests crops at all growth stages, from seedlings to harvest, causing significant yield losses **(Fergani *et al*., 2023)**. The insect development and reproductive success are closely tied to nutritional factors. The quantity and quality of food consumed by larvae directly influence their growth rate, development time, final body weight, and survival **(Slansky and Scriber, 1985)**. Therefore, a reduction in feeding activity can disrupt normal development, decrease weight gain, and increase mortality **(Van Duyn, 1971)**. Population performance and growthof herbivorous insects are affected by thenutritional contents/ biochemical attributes of host plants **(Ismail, 2020; Hemmati *et al.*, 2022; Shirinbeik Mohajer *et al*., 2022).** These substances reduce food consumption without immediately killing the insect, allowing natural enemies to maintain control and preserving ecological balance **(Isman, 2002 and Jeyasankar *et al*., 2010).** Among the entomopathogenic agents used for the biological control of lepidopterous pests, the bacterium *Bacillus thuringiensis* (Bt) has gained special attention. Its use represents an effective control method against insects like cotton leafworm **(Gaaboub, 2004 and Gaaboub *et al*., 2005)**. Several studies havebeen carried out to demonstrate theeffects of host plant types on the different life-history traitsof *S. littoralis* (**Al-Shannaf, 2011; Mohamed *et al*., 2019; Ismail, 2020; Hemmati *et al*., 2022 and Mousavi *et al*., 2023).** Emamectin benzoate, a derivative of avermectins, is a foliar insecticide isolated from the fermentation of *Streptomyces avermitilis*, a naturally occurring soil bacterium. It acts by stimulating the releaseof gamma-aminobutyric acid (GABA), an inhibitory neurotransmitter, which leads to insect paralysis within hours of ingestion **(Tomlin, 2003).** This paralysis ultimately results in death 2–4 days later. It is widely used on various crops, including fruits, vegetables, cereals, tree nuts, and oilseeds. The purpose of this study was to evaluate the efficacy of three insecticides; Protecto 9.4% WP, Speedo 5.7 % WG, and Winsor 24% SC on feeding and mortality of *S. littoralis*.

2. Materials and Methods

2.1. Insect strain

The culture of *Spodoptera littoralis* (Boisd.) used in the present study originated from eggs obtained from a laboratory strain established in the Cotton Leaf Worm Department, Plant Protection Institute, Dokki, Giza. The larval stage was reared and fed on castor bean leaves in the laboratory under constant conditions of 27 ± 2° C and 65 ± 5 R.H according to **El Defrawi *et al*. (1964)**.

2.2. Insecticide application

The tested compounds included three insecticides, as members of different classes of insecticides with novel modes of action introduced in recent years. Most of these insecticides belong to reduced risk insecticides with low mammalian toxicity and a benign profile for non-target organisms:

A- Speedo 5.7 % WG (emamectin benzoate), Daqing Jefene Bio-Chemical Co. Ltd,China, applied at rate of 80g /feddan.

B- Protecto 9.4% W.P (*Bacillus thuringiensis* var. *kurstaki*, 3200 IU), manufactured by the Bio-insecticide Production Unit of the Plant Protection Research Institute, applied at rate of 300 g/feddan.

C- Winsor 24% SC (methoxyfenozide), provided by Agri Sciences Tarim Ve Ilac Urunlerisan Ve Tic. Sti., Turkey, and applied at rate of 37.5 cm³/100 liters of water.

2.3. Tested beet types

Seeds of different beet types in this study, which included sugar, table, and fodder beet, were obtained from the Sugar Beet Research Institute at Sakha Agricultural Research Station.

2.4. Semi-field trial and experimental design

Semi-field trial was carried out in 2023 and 2024 seasons, and the beet type leaves were offered to *Spodoptera littoralis* larvae for feeding in the laboratory of Plant Protection Research Institute at Sakha Agricultural Research Station, Kafrelsheikh. The experimental area was divided into 84 plots in a complete randomized block design. Every treatment was replicated 4 times (10 larvae/ replicate) in addition to controls. The treatments were Protecto, Speedo, and Winsor. Each insecticide was applied at two rates (1/2 and 1.00 of the recommended field rate) using a CP3 sprayer at a volume of 200 liters of water per feddan. For the laboratory bioassay, daily treated cotton leaves were randomly selected from each plot in the field and offered for feeding fourth-instar larvae of *S. littoralis*. Mortality percentages were recorded after 1, 3, 5, and 7 days post-treatment according to **Abbott's formula (1925)**

2.5. Evaluation of nutritional indices

Leaf discs (5 cm diameter) were prepared from beet plants, 60 day- post emergence, using a no-choice feeding bioassay **(Srivastava and Prokesch, 1990, 1991)**, five newly moulted fourth-instar of *S. littoralis* larvae (40-45 mg) were placed in Petri dishes containing a leaf disc. Larvae were initially fed for 24 h, then new leaf was substituted for existing insects, and feeding percentage was recorded after 48h. Each treatment was replicated thrice. The consumed leaf area was measured using a graph sheet method to quantify feeding. The study calculated antifeedant activity **(Singh and Pant, 1980)**, feeding inhibition **(Pande and Srivastava, 2003)**, and feeding percentage **(Purwar and Srivastava, 2003)** as follow**:**

Antifeedant activity (%) = [(% Leaf protection in treated disc - % Leaf protection in control disc) / (100 - % Leaf protection in control disc)] × 100

Feeding inhibition (%) = [(C - T) / (C + T)] x 100

Where: C = consumption of control disc T = consumption of treated disc

Leaf area protected (%) = (Leaf area left / Total leaf area supplied) x 100

Feeding percentage (%) = [(Initial leaf area provided for feeding) - (Leaf area left after feeding)] / Initial leaf area provided x 100

Effect of different beet types

Homogenate preparation

Leaves of beet samples were collected randomizely and put in ice box, then transmitted to laboratory, mixed and chopped to weight 3 gm. One-gram weight of every replicate was grinding by liquid nitrogen in special grinding; 0.5g was sampled and mixed with 0.7 ml of buffer solution (sodium phosphate, potassium phosphate with pH 7). Samples were placed on centrifugal force 11000 rpm for 15 minutes, then supernatants were separated and immediately frozen in biochemical analysis and used for the following assay:

Protein content was determined by method of **Bradford (1976)**. The method of **Singleton *et al.*, 1965** was adapted to determined total polyphenol content.

2.6. Statistical analysis

Statistical analysis was conducted using one-way and two-way analysis of variance (ANOVA) with **Costat** software and compared using the least significant difference (L.S.D.) at 5%. Differences were considered statistically significant at $p \leq 0.05$.

3. Results and Discussion

3.1. Effect of tested beet types on feeding of cotton leafworm

From the data summarized in Table (1), it was observed that food of larvae has a noticeable effect on leaf area consumed by *S. littoralis* for 24 and 48 h. Table beet treatment proved to be the most favorable (2.29 cm^2 / larva) for feeding larvae, while lower consumed leaves resulted from larvae fed on both fodder and sugar beet type leaves (1.10 and 1.29 cm^2 /larva) without significant differences between them, respectively.

Table (1). Consumed leaf area by *Spodoptera littoralis* fed on three beet types

Beet type	Mean area of leaf consumed cm^2	Mean leaf area left cm^2	Mean leaf area protected%	feeding %	Mean area of leaf consumed cm^2	Mean leaf area left cm^2	Mean leaf area protected %	feeding %
	24h				48h			
Sugar beet	1.29± 0.07	18.33	93.41	6.59± 0.36	1.85±0.07	17.77	90.57	9.43±0.38
Table beet	2.29± 0.20	17.33	88.35	11.65± 0.10	2.52± 0.17	17.10	87.14	12.86±0.89
Fodder beet	1.10± 0.05	18.52	94.39	5.61± 0.27	1.66±0.02	17.96	91.52	8.48±0.09
L.S.D	0.251			1.282	0.508			2.590

After 24 h, the maximum feeding percentage (11.65 %) was recorded in table beet type, compared with 6.59 and 5.61% for sugar and fodder beets, respectively. After 48 h from feeding 4th instar larvae of *S. littoralis*, consumed leaf area and feeding percentage were more obvious than feeding for 24 h, as they increased at all beet types.

Feeding percentage of *Spodoptera littoralis* reared on different beet types treated with some insecticides, at 1/2 and1 field rates

Feeding percentage of *S. littoralis* for 24 h at 1/2 and 1 recommended rates of treatment was studied and results were shown in Tables (2 and 3). At 1/2 recommended rate, based on the consumed leaf area by larva of the 4th instar, it was observed that all the treatments caused a significant reduction of feeding larvae (consumed leaf area) compared to all controls (sugar, table and fodder beets). The lowest consumed leaf area and feeding percentage were significantly recorded in Speedo treatment on table beet (0.59 cm^2/ larva) and 2.99%, while in the rest treatments, the consumed leaf area and feeding percentage varied from 0.74 cm^2 /larva and 3.79% for Winsor on sugar beet to 2.29 cm^2 / larva and 11.65% for control of table beet with significant differences between them, respectively. Any substance that reduces food consumption by an insect can be considered feeding deterrent **(Isman, 2002)**. Also, the maximum antifeedant activity was recorded in Speedo and Winsor treatments on table beet, as they were 74.35 and 62.50 % without significant differences between them, respectively, while it was 4.18 % for Protecto treatment on sugar beet. The obtained results agree with the findings of **Gaaboub *et al.* (2012)** who found that protecto gave the lowest antifeeding activity against the 4th larval instar of *S. littoralis* Also, **El-Fergani (2019)** showed that Protecto caused a significant reduction in *S. littoralis* infestation up to five days post treatment and theoverall reduction of larvae population after treatment 57.92% .

As for field rate after 24 h, control of table beet significantly gave high value of 2.29 cm^2 /larva and 11.65%, for consumed leaf area and feeding percentage of 4th larval instar of *S. littoralis*, respectively. The lowest consumed leaf area and feeding percentage were recorded for Speedo on sugar beet by 0.13 cm^2 /larva and 0.65%, respectively. Also, all beet types gave maximum antifeedant activity by 90.17, 92.28 and 97.23% for Speedo treatment on sugar, fodder and table beet, respectively, without significant difference between them, while the lowest antifeedant of larva (15.42%) resulted from Bt treatment on sugar beet type. After 48 h of exposure, table beet control was the highest value (2.52 cm^2 /larva and 12.86%) for consumed leaf area and feeding percentage of 4th larval instar of *S. littoralis*, respectively. While Speedo on sugar beet, table beet and fodder beet in addition to winsor on sugar beet, table beet and fodder beet besides Protecto on fodder beet were the lowest values without significant difference between them. In addition, the maximum antifeedant activities were significantly recorded in Speedo on sugar, table and fodder beet types by 100% for them, whereas 12.28% was recorded in Protecto treatment on sugar beet.

Table (2). Feeding percentage of *Spodoptera littoralis* larvae fed on beet types treated with some insecticides, at 1/2 field rate

Treatment	Mean area of leaf consumed cm^2	Mean leaf area left cm^2	Mean leaf area protected%	Anti-feedant activity	Feeding inhibition %	Feeding %	Mean area of leaf consumed cm^2	Mean leaf area left cm^2	Mean leaf area protected %	Anti-feedant activity	Feeding inhibition %	Feeding %
	24 h						48 h					
Sugar beet												
Speedo 5.7 % WG	1.06± 0.072	18.56	94.61	17.37±0.93	10.07	5.39 ± 0.36	0.08±0.008	19.54	99.58	95.32± 4.68	91.79	0.42± 0.04
Winsor 24% SC	0.74± 0.023	18.88	96.21	42.23± 3.13	26.86	3.79±0.11	0.19±0.005	19.43	99.03	89.72± 0.23	81.35	0.97± 0.03
Protecto 9.4% WP	1.24± 0.77	18.38	93.68	4.18± 0.82	2.14	6.32± 0.39	1.75±0.07	17.87	91.10	5.61± 0.58	2.89	8.90± 0.39
Control	1.29± 0.07	18.33	93.41	-------	-----	6.59± 0.37	1.85±0.07	17.77	90.57	------	-----	9.43± 0.38
Table beet												
Speedo 5.7 % WG	0.59± 0.02	19.03	97.01	74.35± 0.55	59.18	2.99± 0.09	0.04±0.02	19.58	99.79	98.29± 0.89	96.66	0.21± 0.11
Winsor 24% SC	0.86± 0.06	18.76	95.63	62.50± 2.87	45.59	4.37± 0.30	0.49± 0.006	19.13	97.52	80.53± 1.35	67.45	2.48± 0.03
Protecto 9.4% WP	2.14± 0.03	17.48	89.09	6.42± 0.66	3.32	10.91±0.15	2.44±0.16	17.18	87.58	3.42± 0.12	1.74	12.42± 0.84
Control	2.29± 0.02	17.33	88.35	-----	------	11.65±0.11	2.52±0.17	17.10	87.14	----	-----	12.86± 0.89
Fodder beet												
Speedo 5.7 % WG	0.89± 0.02	18.73	95.45	18.53± 2.82	10.26	4.55± 0.09	0.21±0.05	19.41	98.93	87.35± 3.03	77.80	1.07± 0.25
Winsor 24% SC	0.88± 0.04	18.74	95.53	19.72± 0.65	11.24	4.47± 0.19	0.24±0.03	19.38	98.78	85.61± 1.67	74.91	1.22± 0.16
Protecto 9.4% WP	0.98± 0.02	18.64	95.02	10.95± 2.69	5.84	4.98± 0.09	0.87±0.04	18.75	95.57	47.74± 2.05	31.40	4.43± 0.22
Control	1.10± 0.05	18.52	94.39	------	-----	5.61± 0.26	1.66±0.02	17.96	91.52	----	------	8.48± 0.09
L.S.D	0.144	------	------	13.60	------	0.736	0.121	------	------	6.28	------	1.288

Leaf disc = 5 cm diameter. Area of leaf disc = 19.62 cm^2 SE = Standard error. Means were compared using the least significant difference (L.S.D.) at 5%. Differences were considered statistically significant at $p \leq 0.05$.

Table (3). Feeding percentage of *Spodoptera littoralis* larvae fed on beet types treated with some insecticides, at 1.00 field rate

Treatment	Mean area of leaf consumed cm^2	Mean leaf area left cm^2	Mean leaf area protected %	Anti-feedant Activity %	Feeding inhibition%	Feeding %	Mean area of leaf consumed cm^2	Mean leaf area left cm^2	Mean leaf area protected %	Anti-feedant Activity %	Feeding inhibition%	Feeding %
	24 h						48 h					
Sugar beet												
Speedo 5.7 % WG	0.13± 0.01	19.49	99.35	90.17± 0.73	82.12	0.65±0.04	0.00±0.00	19.62	100.00	100.00±0.00	100.00	0.00±0.00
Winsor 24% SC	0.56± 0.04	19.06	97.15	56.46±3.64	39.51	2.85± 0.18	0.14± 0.02	19.48	99.26	92.15±1.09	85.47	0.74±0.086
Protecto 9.4% WP	1.09± 0.06	18.53	94.43	15.42± 1.67	8.37	5.57±0.31	1.62± 0.08	18.00	91.73	12.28±1.81	6.56	8.27±0.40
Control	1.29± 0.07	18.33	93.41	----	-----	6.59± 0.36	1.85±0.07	17.77	90.57	-----	-----	9.43±0.38
Table beet												
Speedo 5.7 % WG	0.06± 0.01	19.56	99.68	97.23± 0.43	94.62	0.32± 0.05	0.00±0.00	19.62	100.00	100.00±0.00	100.00	0.00±0.00
Winsor 24% SC	0.76± 0.05	18.86	96.14	66.88± 2.57	50.35	3.86± 0.28	0.26±0.03	19.36	98.66	89.63±0.74	81.22	1.34±0.16
Protecto 9.4% WP	1.79± 0.07	17.83	90.89	21.80± 3.72	12.33	9.11± 0.35	2.21±0.14	17.41	88.71	11.65± 0.65	6.44	11.29± 0.70
Control	2.29± 0.20	17.33	88.35	-----	-----	11.65±0.10	2.52± 0.17	17.10	87.14	-----	------	12.86±0.89
Fodder beet												
Speedo 5.7 % WG	0.08± 0.02	19.54	99.58	92.28± 1.76	85.76	0.42± 0.08	0.00±0.00	19.62	100.00	100.00±0.00	100.00	0.00±0.00
Winsor 24% SC	0.77± 0.02	18.85	96.06	29.24± 5.12	17.33	3.94± 0.12	0.21±0.02	19.41	98.92	87.24± 0.94	77.39	1.08±0.70
Protecto 9.4% WP	0.72± 0.06	18.90	96.31	33.32± 8.68	20.66	3.69±0.32	0.18±0.02	19.44	99.07	88.98±0.97	80.18	0.93±0.08
Control	1.10± 0.05	18.52	94.39	----	----	5.61± 0.27	1.66±0.02	17.96	91.52	----	-----	8.48±0.09
L.S.D	0.143	----	----	12.44	----	0.720	0.216	----	----	7.288	----	1.108

Leaf disc = 5 cm diameter. Area of leaf disc = 19.62 cm^2 SE = Standard error. Means were compared using the least significant difference (L.S.D.) at 5%. Differences were considered statistically significant at $p \leq 0.05$

Table (4). Efficacy of the tested treatments against *Spodoptera littoralis* larvae infesting beet plants under semi- field conditions during 2023 and 2024 seasons at 1/2 field recommended rate

Treatment	Mortality percentages of *S. littoralis larvae* at the indicated days post spray									
	2023					2024				
	1	3	5	7	Mean ± SE	1	3	5	7	Mean ± SE
Sugar beet										
Speedo 5.7 % WG	27.50	47.50	85.71	100.00	65.18 ±1.68	32.50	52.50	66.96	100.00	62.99 ± 2.21
Winsor 24% SC	0.00	22.50	85.71	100.00	52.05 ± 0.76	0.00	20.83	73.21	100.00	48.51 ± 4.17
Protecto 9.4% WP	0.00	30.00	51.79	65.83	36.90 ± 2.38	0.00	28.89	40.18	58.93	32.00 ± 2.73
Control	----	----	----	----	----	----	----	----	----	----
Table beet										
Speedo 5.7 % WG	37.50	60.00	87.50	100.00	71.25 ± 2.93	40.00	56.39	70.09	100.00	66.62 ± 1.16
Winsor 24% SC	0.00	5.00	76.04	100.00	45.26 ± 1.37	0.00	2.50	60.27	100.00	40.69 ± 1.68
Protecto 9.4% WP	0.00	17.50	39.58	85.71	35.70 ± 2.32	0.00	15.56	22.77	76.04	28.59 ± 3.13
Control	----	----	----	----	----	----	----	----	----	----
Fodder beet										
Speedo 5.7 % WG	30.00	45.00	64.38	100.00	59.84 ± 2.37	32.50	50.27	56.67	100.00	59.86 ±2.68
Winsor 24% SC	0.00	12.50	69.38	100.00	45.47 ± 1.18	0.00	10.00	55.83	100.00	41.46 ± 3.44
Protecto 9.4% WP	0.00	35.00	46.88	92.26	43.53 ± 2.30	0.00	26.25	39.17	85.83	37.81 ± 2.34
Control	----	----	----	----	----	----	----	----	----	----
L.S.D					6.145					8.081

Mean was compared using the least significant difference (L.S.D.) at 5%. Differences were considered statistically significant at $p \leq 0.05$.

Table (5). Efficacy of the tested treatments against *Spodoptera littoralis* larvae infesting beet plants under semi- field conditions during 2023 and 2024 seasons at 1.00 field recommended rate

Treatment	Mortality percentages of *S. littoralis larvae* at the indicated days post spray									
	2023					2024				
	1	3	5	7	Mean ± SE	1	3	5	7	Mean ± SE
Sugar beet										
Speedo 5.7 % WG	72.50	100.00	100.00	100.00	93.13 ± 0.63	70.00	100.00	100.00	100.00	92.50 ± 1.02
Winsor 24% SC	0.00	62.50	100.00	100.00	65.63 ± 0.63	0.00	52.50	100.00	100.00	63.13 ±0.84
Protecto 9.4% WP	0.00	52.50	70.83	100.00	55.83 ± 1.87	0.00	41.94	62.95	83.93	47.20 ± 1.48
Control	----	----	---	----	----	----	----	----	----	----
Table beet										
Speedo 5.7 % WG	77.50	100.00	100.00	100.00	94.38 ± 0.63	75.00	100.00	100.00	100.00	93.75 ±0.72
Winsor 24% SC	0.00	22.50	100.00	100.00	55.63 ± 1.20	0.00	31.46	100.00	100.00	57.86 ± 1.62
Protecto 9.4% WP	0.00	42.50	57.64	92.86	48.25 ± 2.17	0.00	39.86	50.00	90.63	45.12 ±2.40
Control	----	----	----	----	----	----	----	----	----	----
Fodder beet										
Speedo 5.7 % WG	70.00	100.00	100.00	100.00	92.50 ± 1.02	62.50	100.00	100.00	100.00	90.63 ± 0.63
Winsor 24% SC	0.00	45.00	100.00	100.00	61.25 ± 0.72	0.00	50.09	100.00	100.00	62.52 ± 1.45
Protecto 9.4% WP	0.00	50.00	88.75	95.83	58.65 ± 1.40	0.00	45.09	69.17	90.83	51.27 ± 1.44
Control	----	----	----	----	----	----	----	----	----	----
L.S.D					3.460					3.882

Mean was compared using the least significant difference (L.S.D.) at 5%. Differences were considered statistically significant at $p \leq 0.05$.

Effect of tested insecticides as foliar spray on feeding percentage of *Spodoptera littoralis* on beet types under semi field conditions

The persistence of any insecticide is defined as its capability to resist breaking and to be stable and effective with the same physical, chemical, and functional characteristics under environmental conditions **(Helfrich, 2009).** In the field, many factors affect the persistence of insecticides starting from their characteristics including stability, volatility, solubility, and formulation through the site and method of application and the environmental conditions (**Beggel *et al*., 2010).** In addition to the characteristics of the soil and water and their resistance to degradation, the characteristics of the crop, such as the kind of plant structure, stage, and growth rate, also might have an impact on the persistence of the insecticides.

Data in tables (4 and 5) summarize toxicity of Protecto, Winsor and Speedo formulations at 1/2 and 1 field recommended rates against *S. littoralis* during two successive beet seasons; 2023 and 2024. As for percent mortality at ½ field rate, the obtained results showed that mortality was different from one treatment to another and the differences were significant. It was highest for Speedo on table and sugar beet by 71.25 and 65.18%, respectively in 2023 season, while minimum mortality was recorded in Protecto treatment on table and sugar beet by 36.90 and 35.70%, respectively.

In 2024 season, the results revealed that Speedo treatment on all beet types significantly increased mortality of *S. littoralis* by 66.62, 62.99 and 59.86 % for Speedo on table, sugar and fodder beet, respectively. Whereas the lowest mortality was 28.59 and 32.00% for Protecto treatment on table and sugar beet, respectively. The obtained results are in agreement with **El-Naggar (2013) and El-Zahi (2013)** who mentioned that emamectin benzoate was effective in reducing fecundity and egg hatchability of *S. littoralis.*

With regard to the mortality at 1 field rate, it was clear that efficiency of Speedo treatment on table, sugar and fodder beet caused highest significant mortality in *S. littoralis* by 94.38, 93.13and 92.50% at 1 field rate, respectively, against 4th instar of *S. littoralis* larvae during 2023 beet season without significant between them. On the other hand, Protecto treatment on table beet decreased the mortality by of *S. littoralis* by 48.25%. As for the second season, the same trend of results was observed as shown in 2023 season. The mortality of *S. littoralis* was 93.75, 92.50 and 90.63% for Speedo on table, sugar and fodder beet at 1.00 field rate, respectively. While it was 45.12 and 47.20% for Protecto treatment on table and sugar beet.

The obtained results agree with thoseof **Said *et al*. (2012)** who found that Protecto was the least efficient compound on *S. littoralis* which gave 41.76% reduction only as initial kill (after five daysfrom treatment) on sugar beet plants. **Also, Abd El-rahman *et al.* (2007)** tested the direct and latent effects of thegrowth inhibitor, lefenuron and thecombination of iefenuron/deltanet on the development of *S. littoralis* larvae, both compounds proved to be toxic to the test insect larvae. Also, *S. littoralis* larvae fed on clover leaves lasted for shorter period by 18.00 days, compared to those fed on sugar beet leaves by 25.20 days (**Mohamed *et al*., 2019**). **Soliman *et al.* (2024)** indicated that biological parameters of *S. littoralis* on Giza 92, Giza 94 and Giza 96 varieties gave greater developmental rates and fecundity on Giza 96 and Giza 94, while poorer development was found on Giza 92 variety. Comparison based on overall mean during the whole experimental period, **Rashwan (2013)** recorded significant reduction in consumption index and growth rate in both of LC_5 (0.061 ppm) and LC_1 (0.017ppm) treatments of emamectin benzoate on *S. littoralis*. The results clearly indicated that emamectin benzoate was the most effective compound, while *Beauveria bassiana* was the least effective one on *S. littoralis*, (**Madkour *et al*., 2024**). Also, **Gaaboub *et al.* (2012)** mentioned that the overall larval mortalities after treatment with lannate and protecto on the 4th larval instar of *S. littoralis* were 48.3 - 70.0 and 20.0 - 50.0%, respectively.

Table (6). Main chemical composition of *Beta vulgaris* leaves

Beet type	Total Protein (mg/g)	Total polyphenol [mg GAE.g-1]
Sugar beet	3.78± 0.101	25.02± 0.434
Table beet	3.54± 0.043	23.43± 0.146
Fodder beet	3.66± 0.115	25.01± 0.066
L.S.D	0.393	1.022

Mean was compared using the least significant difference (L.S.D.) at 5%. Differences were considered statistically significant at $p \leq 0.05$. GAE – gallic acid equivalent

Protein content and total polyphenol

Protein Content: The protein value is relatively consistent across all three beet types, It was observed that all beet types gave non – significance between them, however, sugar beet showed a marginally higher protein content (3.78%) compared to table beet (3.54%) and fodder beet (3.66%) (Table 6). This consistency suggests that protein is not the primary distinguishing parameter among these beet types. These values are in line with general nutritional data for beets, which are not typically considered a high-protein food source.

It is generally accepted that lowdietary protein can cause an increase in therate at which larvae feed **(Slansky 1993);** conversely, a high protein diet canreduce feeding rates **(Mattson, 1980).** According to **Cohen and Patana (1984),** although there was nodifference in nitrogen content in the artificial and bean diets, *H. zea* larvae fed on theartificial diet had amuch higher nitrogen content than the larvae reared on thebean diet, suggesting that larvae fed artificial diet passed more material through their systems and accumulated more body nitrogen than those feed beans.

The highest polyphenol value was found in sugar and fodder beet by 25.02 and 25.01 mg GAE.g-1, respectively. (Table 6) while 23.43 mg GAE.g-1 was the least value for table beet. This is a crucial observation because polyphenols are important bioactive compounds with recognized antioxidant, anti-inflammatory, and health-promoting properties. The high polyphenol content in sugar and fodder beets, particularly in their leaves and pulp, makes them valuable sources of these compounds, which are often overlooked in favor of the more widely consumed table beet. Analysis of nutritional indices can leadto understanding of behavioral and physiological basis of insect response to hostplants **(Lazarevic and Peric-Mataruga 2003).** Lower fitness of *H. armigera* on some host plants may be due to thepresence of some secondary phytochemicals in these plants, or absence of primary nutrients necessary for growth and development. **Carrillo *et al.* (2019)** compared the content of phenolic compounds in organic and conventionally cultivated beet root; the effect of the production system on the total polyphenol content was found to depend on the variety. The referenced study was focused on verifying whether or not nutritional differences can be demonstrated between beet root labelled as bio/organic or traditional/conventional, and its results regarding higher content of phenolics in organic-labelled vegetables resemble our findings.

The interaction between herbivorous of insects and plants has always been ahot topic for researchers **(Arimura**, **2021; Brbero and maffei 2023).** Moreover, other scholars have also studied theeffects of crop differences on the feeding preferences, growth and development of phytophagous pests. **Liu *et al.* (2021)** found significant differences in thefeeding preferences of *Spodoptera frugiperda* larvae for different wheat varieties. The larvae preferred varieties such as HM33 and fed less on LY502, and feeding different wheat varieties affected thegrowth and development of *S. frugiperda* larvae. **Yang Yang *et al.* (2014)** found that different rice varieties affected the survival rate and adult longevity of *Sesamia inferens* larvae. **He *et al.* (2024)** also found that different varieties of pepper leaves affected the growth and mortality of *S. litura* larvae. The mentioned studies have emphasized the key role of cropvarieties in the prevention and control ofphytophagous insects.

In summary, thefeeding preferences of phytophagous insects for different varieties ofcrops is a common phenomenon, and this preference often has aprofound impact on thegrowth, development, and reproduction of insects. Feeding percentage rate of 4th instar *S. littoralis* larvae fed on different beet leaves treated with Protecto, Winsor and Speedo at 1/2 and 1.00 field rates was decreased.

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