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Impact of Seedling Deadlines and Some Insecticides against *Spodoptera frugiperda* (Smith) Infesting Maize at Qalyobia Governorate, Egypt.

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ABSTRACT

The maize, *Zea mays* (Lederer) (white single cross 2036 variety, Hytech company) is the first economically crop of the most important and widely grown as a staple food in many parts of the Egypt and world. Maize infested with fall armyworm (FAW), (*Spodoptera frugiperda*) is a species in the order: Lepidoptera, Fam: Noctuidae**.** The field experiment was conducted at Agricultural Research station "Qaha" in Qalyobia Governorate, Egypt. The paper aimed to study the impact of seeding dates on maize on infesting with FAW, *Spodoptera frugiperda* and the efficiency of some insecticides against FAW larvae. The statistical analysis illustrates that there are negative correlation relation (R= -0.36) between seedling dates, population and average temperature but these relations convert to become positive correlation relation with relative humidity and wind speed whereat (R= 0.12 and 0.08). Specially seedling date 14th and 27th May 2021, data indicate that each maize plants are healthy and free from infestation with FAW larvae. While, other dates 15 July and 5 August, data illustrate that infestation was speedily spread on maize plants, wherever larvae attack all maize plants. On the other hand, In case of efficiency of insecticides on mean reduction % of FAW larvae, The statistical analysis, illustrates there are significant differences between treatments in case of initial effect and mean general reduction % the results were summarized that the compound Indoxacarb recorded highly initial effect 84 % after 24 hours from the first and second application, while the Emamectin benzoate compound recorded 76.66 and 74.5 % reduction in case of residual effect and mean general % reduction.

INTRODUCTION

The maize, *Zea mays* (Lederer) is the first economic crop of the most important and widely grown as a staple food in many parts of the Egypt and world, maize is consumed directly by humans, producing ethanol, starch, syrup and animal feed. Maize infested with many insects from it, the fall armyworm (*Spodoptera frugiperda*) is a species in the order: Lepidoptera, Fam: Noctuidae and is the larval life stage of a fall armyworm moth. The term "armyworm" can refer to several species, often describing the large-scale invasive behavior of the species' larval stage. It is regarded as a pest and can damage and de stroy a wide variety of crops which causes large economic damage. Fall armyworm *Spodoptera frugiperda*is a pest that attacks maize plants. This pest has been reported in the Americans to cause serious damage

to maize. The pest causes yield loss in maize in the US due to falling armyworm, Blanco *et al*. (2016) showed that the pest attack many crops; maize, cotton, rice, sorghum, and others. In Brazil and the United States, *S. frugiperda* is a major pest Blanco et al (2016). Fall armyworm larvae can cause a 34 to 38% yield loss. If an attack occurs and alate start in the early phase the attack can reach 100% Avila *et al.* (1997). Fotso *et al.* (2019), has also conducted a case study in Cameroon Africa on damage and distribution as well as farmers' responses to this pest. Efforts to control the fall armyworm attack must be always followed. In the United States, fall armyworm is a major pest of maize. Many technologies have been studied to control these pests. In the USA, the researcher has studied the control of *S. frugiperda* using sterile insect techniques Carpenter *et al.* (1997). Researchers using natural enemies for control in America by Hay-Roe (2016), to the known distribution pattern of *S. frugiperda* parasitoid in maize in Florida. In September 2017, the level of attack of this pest was also reported on the African continent, especially in Egypt Heinrichs *et al.* (2017), and Fatoretto *et al.* (2017) in Brazil has conducted research using *Bacillus thuriengiensis* to fall armyworm control. Nagoshi and Meagher (2004) have also observed the behavior and spread of fall armyworm in two types of hosts in Florida, USA. Nelly *et al.* (2020) The results of the observations were that several trademarks of maize varieties grown by farmers were: Pioneer 32, Pertiwi, Bisi 18, NK7328, and NK212. The symptoms of this pest attack were the same for all varieties of maize, while the attack rate was significantly different at the 5% level. The attack rate ranged from 6.0 to 96.0%. The lowest attack percentage was on variety Bisi18, and the highest was on variety NK212. The population of *S. frugiperda* larvae was found in all varieties of maize with an average of 0.70 larvae per stem. Abd Elmageed et al 2021 found two parasitoids, *Exoristasorbillans*(Wiedemann) and *Pseudogonia rufifrons*(Wiedemann) (Diptera; Tachinidae) and one parasitoid species *Microplitis*sp. (Hymenoptera: Braconidae), were detected from infected FAW larvae which, were collected from maize fields during August, September, and October. The highest parasitism rate was recorded on 1st October in two locations at Aswan at 30.77%. Moreover, some biological aspects of FAW were recorded, which an average of 156.13 ±16.57 eggs/mass emerging after an average of 3.47 days, with a hatchability of 89.18%. Larval and pupa average duration were 20.93 and 12.60 days, respectively, pre-oviposition, oviposition and post-oviposition were 11, 5.13 and 4.93 days respectively. The paper aimed to study the impact of seeding dates on maize on infesting with fall armyworm, *Spodoptera frugiperda*, and the efficiency of some insecticides against fall armyworm larvae.

MATERIALS AND METHODS

Experimental Design:

1**. Seedling Dates:**

The field experiment was conducted at Agricultural Research station "Qaha" in Qalyobia Governorate, Egypt. Maize, *Zea mays*((white single cross 2036 variety, Hytechcompany) were seedling on 17th, 24th May, 15th July and 5th August 2021, to study full armyworm presence and attack on steam maize plants, selected area about 700 m^2 per the fourth periods, area 700 m^2 divided into 12 plots, area per seedling date was 175 m^2, area to each plot was 58.3 m^2, used three plots per seedling date. 30th plants were randomized selected for examination after 25 days from seedling and backtrace of fall armyworm (FAW) (larvae), larvae number were directly counted and recorded on plants in the field and the results were statistical analysis.

2. Efficiency of Some Insecticides Against FAW Larvae:

The field experiment was conducted at Agricultural Research Station "Qaha" in Qalyobia Governorate, Egypt. Maize, *Zea mays* (white single cross 2036 variety, Hytechcompany) were seedling on 5th August 2021, to study the efficiency of some insecticides including Indoxacarb, emamectin benzoate, methomyl and Lufenuron mixed with Emamectin benzoate. The insecticides, common name, trade name, concentration & formulation and rate of application it is obvious that in Table (1), these insecticides were sprayed to damage reduction on maize plants, plant age during spray 36 days and 46 days from seeding date, date of application was 11th and21st September 2021. A selected area of about 630 m^2, divided into 15 plots, each treatment repeated three times, the insecticides and control distributed in the experimental area. The experimental area was sprayed by a knapsack sprayer (dorsal motor) twice using insecticides and water alone in case check treatment. Randomized selected 30th maize plants, to monitor FAW larvae and record the number, before application and after 1st, 3rd, 5th and 10th day from the application after the first and second spray. Larvae livingly were accounted and recorded, and the reduction percentage of larvae populations was calculated according to the equation of Henderson and Tilton (1955). Statistical analysis was conducted using SAS.

Table 1: Insecticides used, common, Trade name and application rate:

Common name	Trade name	Concentration and formulation	Rate of Application
Indoxacarb	Diacarb	**15 % SC**	100 ml/100 Liter water.
Emamectin benzoate	Delta laym	**5% EC**	45 ml/100 Liter water.
Methomyl	Chokmail	**90 % SP**	300gm./ Faddan
Emamectin benzoate + Lufenuron	Dinim-vet	**45 % WG**	45 gm / 100 Liter water

RESULTS AND DISCUSSION

Effect of Seeding Dates and Some Abiotic Factors on The Population of Fall Armyworm Larvae:

Data tabulated in Tables (2 and 3), show the impact average of daily temperature (maximum and minimum), Relative humidity and wind speed on the population of FAW larvae through 4th different seedling dates. The statistical analysis illustrates that there is negative correlation relation (R= -0.36) between seedling dates, population and average temperature but these relations convert to become positive correlation relation with relative humidity and wind speed whereat (R= 0.12 and 0.08). Initiating by Table 2, especially seedling date 14th and 27th May 2021, data indicate that each maize plants are healthy and free from infestation with FAW larvae.

While, other dates 15 July and 5 August 2021 in Table (3), data illustrate that infestation was speedily spread on maize plants, wherever larvae attack all maize plants, wherever, the infestation on 15 July appeared from 1 September to 13 October recorded 3 to 39 larvae and at 5 august the data indicate that infestation beginning from 15 September to 27 October recorded 10 to 48 larvae. the damage increased gradually by time from 1 September to 27 October.

Table 2: Effect of two seedling dates and some abiotic factors on the population of FAW larvae:

Dates	Average No.of larvae	Average of Temperature	Average of RH	Average Wind speed	Dates	Average No.of larvae	Average of Temperature	Average of RH	Average Wind speed
7/7	**0.0**	**31.03**	**43.86**	**1.0**	**14/7**	**0.0**	**29.64**	**51.46**	**0.9**
14/7	**0.0**	**30.13**	**59.65**	**0.8**	**21/7**	**0.0**	**31.22**	**48.6**	**0.9**
21/7	**0.0**	**29.64**	**51.46**	**0.9**	**28/7**	**0.0**	**32.02**	**40.34**	**1.3**
28/7	**0.0**	**31.72**	**48.6**	**0.9**	**4/8**	**0.0**	**28.65**	**61.7**	**1.0**
5/8	**0.0**	**32.02**	**40.34**	**1.3**	**11/8**	**0.0**	**29.82**	**59.4**	**0.9**
12/8	**0.0**	**28.65**	**61.7**	**1.0**	**18/8**	**0.0**	**32.24**	**58.48**	**0.6**
19/8	**0.0**	**29.82**	**59.04**	**0.9**	**25/8**	**0.0**	**33.80**	**42.76**	**0.8**
R	**-**	**-0.36**	**0.12**	**0.08**	**R**	**-**	**-0.36**	**0.12**	**0.08**

Table 3: Effect of seedling dates and some abiotic factors on the population of fall armyworm**:**

Dates	Average No.of larvae	Average of Temperature	Average of RH	Average Wind speed	Dates	Average No.of larvae	Average of Temperature	Average of RH	Average Wind speed
1/9	**9**	**29.23**	**58.23**	**1.3**	**15/9**	**15**	**28.81**	**53.52**	**0.8**
8/9	**3**	**28.62**	**60.54**	**1.0**	**22/9**	**42**	**28.81**	**51.33**	**1.0**
15/9	**8**	**32.47**	**40.19**	**0.3**	**29/9**	**48**	**29.15**	**56.18**	**0.3**
22/9	**9**	**28.12**	**50.99**	**0.5**	**6/10**	**12**	**26.10**	**56.39**	**0.5**
29/9	**39**	**28.81**	**53.52**	**0.8**	**13/10**	**15**	**26.17**	**60.04**	**0.8**
6/10	**15**	**28.81**	**51.43**	**1.1**	**20/10**	**18**	**24.64**	**58.1**	**1.1**
13/10	**21**	**29.15**	**56.18**	**0.8**	**27/10**	**10**	**24.33**	**58.8**	**0.8**
R	**-**	**-0.36**	**0.12**	**0.08**	**R**	**-**	**-0.36**	**0.12**	**0.08**
Std	**13.63**	**2.26**	**6.81**	**0.221**		**13.63**	**2.26**	**6.81**	**0.221**

2. Effect of Insecticides on Mean Number of FAW Larvae:

The FAW larvae caused large damage to maize plants in the late period during the summer season, wherever there are no natural enemies at this time on maize plants, so the insecticides used to damage reduction with FAW larvae. Table (4) and Fig. (1**),** show the efficiency of the chemical control on the mean number of FAW larvae through the 2021 summer season (mean to two applications). The large damage with larvae suddenly appeared at experimental, therefore were from necessary using insecticides.

Table 4: Efficiency of insecticides on the population of FAW larvae infesting maize plants.

Treatments	**pretreatments**	**Mean No. of FAW larvae after first and second spray**			
		1 Day	3 Days	5 Days	10 Days
Indoxacarb	30	6	21	36	54
Emamectin benzoate	60	24	24	30	30
Methomyl	42	18	24	30	42
Emamectin benzoate + Lufenuron	48	36	42	48	54
Control	24	30	48	48	48

The data in Table (4) and Fig (1), show that each treatment decreased the mean number of FAW larvae after the first and second spray by 24 hours, but after 3,5 and 10th days the population began increasing, without in case of BB compound, whereat the Emamectin benzoate compound prevent increasing in FAW larvae population beginning from 5th to 10th day, this the prevent may be to stability of the compound.

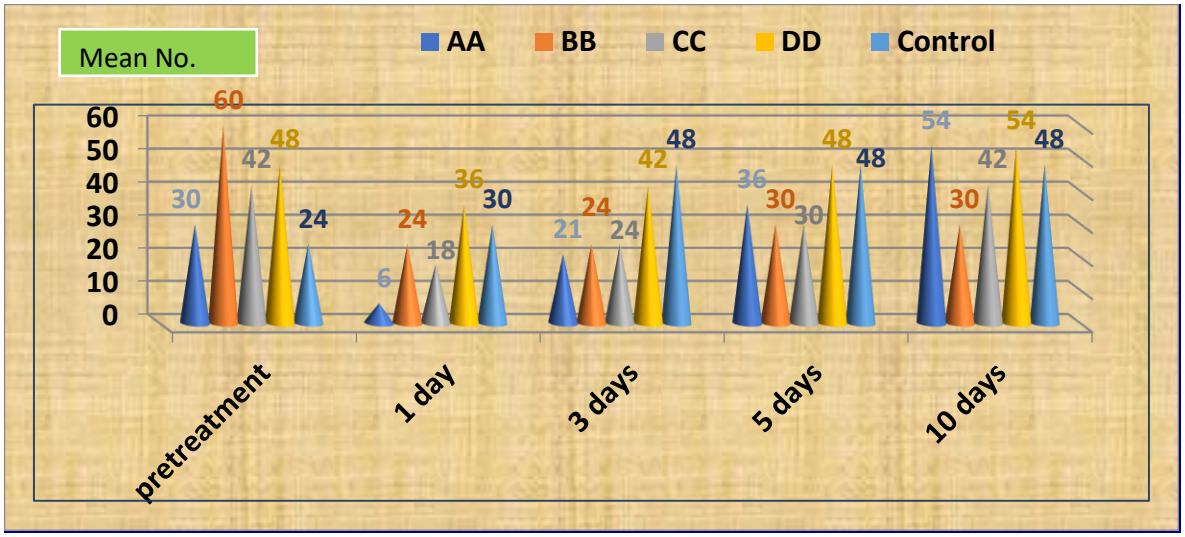

Fig. (1): Efficiency of insecticides on the mean number of FAW larvae infesting maize plants after first and second spray through the 2021 season.

3. Efficiency of Insecticides on Mean Reduction % Of Fall Armyworm Larvae After First and Second Spray:

The study focused on the efficiency of some insecticides from different groups and different formulations to population reducing this pest on maize plans. The statistical analysis results in Table (5) and Fig. (2), illustrate there are significant differences between treatments in case of initial effect (after 24 hours from the first and second spray), wherever the statistical analysis divided treatments into three groups, the first group include Indoxacarb cause reduction % 84.00, the second group include Emamectin benzoate and Methomyl cause reduction 68.00 & 62.71 % while the insecticide Emamectin benzoate + Lufenuron come at the third group 40.00 % reduction. Especially, residual effect (mean after 3,5 and 10 days), The Emamectin benzoate insecticide come at the first order recording 76.66 % reduction while other insecticide descending order as follow Methomyl, Emamectin benzoate + Lufenuron and Indxacarb recording 61.91, 52.68 and 38.33 % reduction, respectively. In the same table (5) the general means the compound Emamectin benzoate recorded 74.5, Methomyl cause 62.85 %, compound Indoxacarb recorded 49.75 and 49.51 in case Emamectin benzoate + Lufenuron compound. From the table, the results were

summarized that the compound Indoxacarb recorded a highly initial effect of 84% after 24 hours from the application but the Emamectin benzoate compound recorded 76.66 and 74.5 % reduction in case of residual effect and mean general % reduction.

Table 5: Efficiency of insecticides on mean reduction % of FAW larvae infesting maize plants.

Treatments	Reduction % mean of*Spodoptera frugiperda* larvae after first and second spray					Residual effect	Mean general To% reduction
	Reduction %	1st Day Initial effect	3 Days	5 Days	10 Days		
Indoxacarb	**Reduction %**	84.00 a	65.00	40.00	10.00	38.33	49.75 ab
Emamectin benzoate	**Reduction %**	68.00 b	80.00	75.00	75.00	76.66	74.5 a
Methomyl	**Reduction %**	65.71 b	71.43	64.29	50.00	61.91	62.85 ab
Emamectin benzoate + Lufenuron	**Reduction %**	40.00 c	64.29	50.00	43.75	52.68	49.51 ab
F value		13.49					2.49
P value		0.0033					0.126
LSD $_{05}$		13.41					25.29

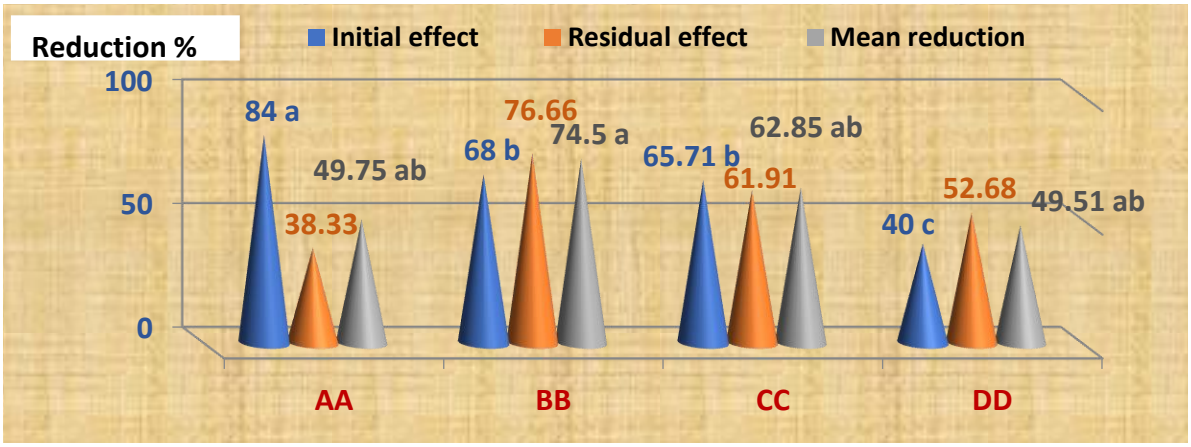

Fig. 2. The efficiency of insecticides on mean reduction % of FAW larvae infesting maize plants.

These results from an agreement with Marcelo et al.2018, found that the results emphasize the potential capability of plant oils when used in management programs against this pest, in which the oils of turmeric, clove and palmarosa show the best controlling potential of this pest from the lowest.

Silva *et al.*,2015 reported high larval mortality of FAW using seed cake extract of *A. indica*. Extracts of many other plants show insecticidal activity against FAW (Batista-Pereira *et al.*, 2006 Some products are based on rotenone, garlic, nicotine, rianodine, quassia and other extracts have been registered worldwide Isman, 1997. Thrash *et al.*,2013 reported that the use of chlorantraniliprole and cyantraniliprole as seed treatments reduced the need for foliar sprays against FAW in soya. In laboratory tests, third carb and clothianidin reduced the number of plants cut or injured by FAW, but chlorpyrifos, fipronil and thiamethoxam (Camillo, Di Oliveira, de Bueno, & Bueno, 2005) and kerosene (Portillo, Meckenstock, & Gómez, 1994) were not effective. Another approach is to apply pesticides to the soil at planting, though this is likely to be less efficient than seed treatments. van Huis (1981) concluded that in experiments in Nicaragua, soil treatment did not exert any control on FAW.

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