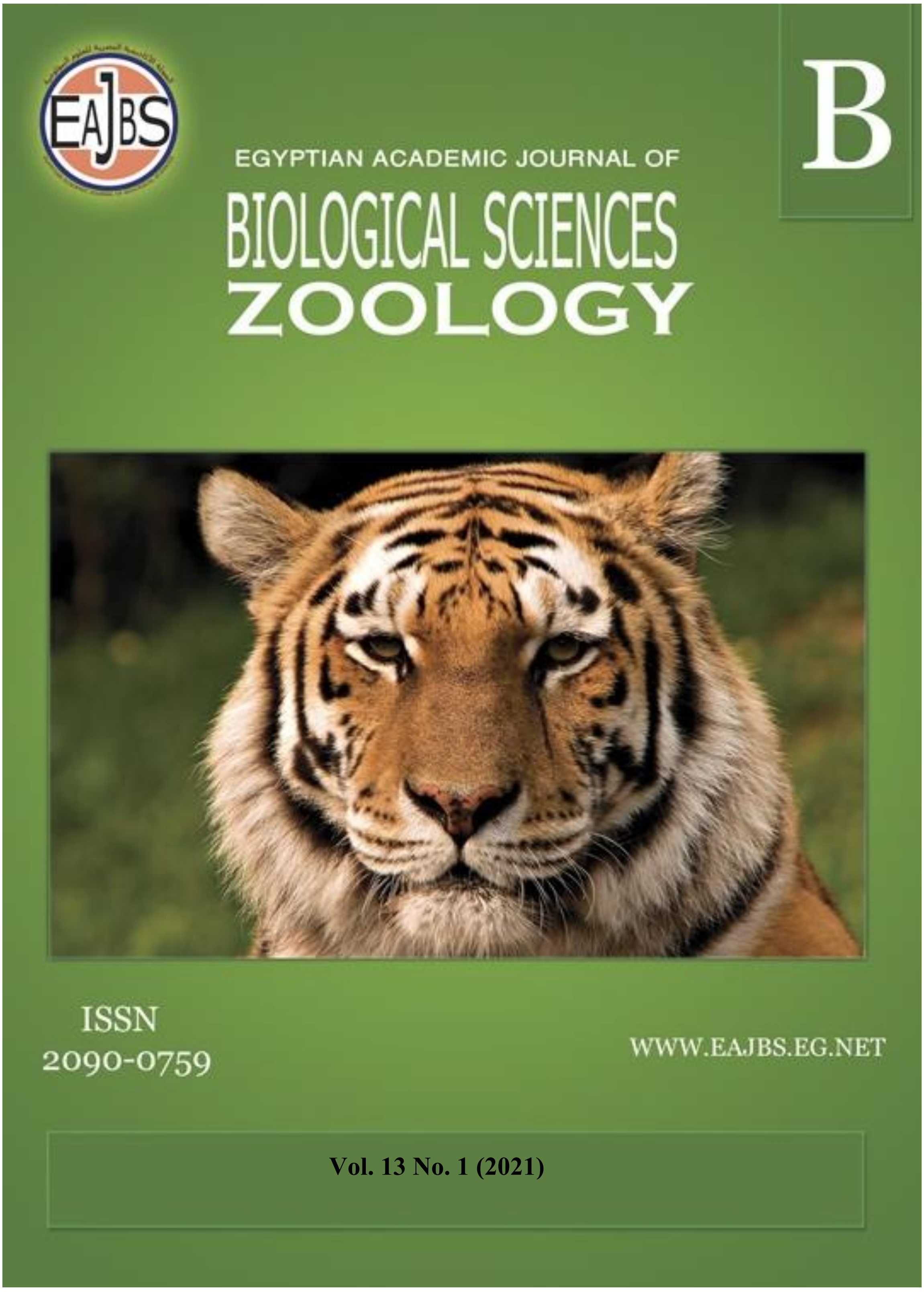

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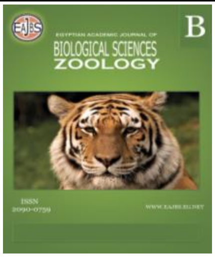

Effect of Seed Soaking and Foliar Spray of Humic Acid and Fulvic Acid on Cotton Plant Pests and Yield, Compared with Some Recommended Pesticides

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ABSTRACT

Two field experiments were conducted at El-Gemmeiza Agricultural Research Station, El-Gharbia Governorate, Egypt during the two seasons 2018 and 2019. The aim of this study was to investigate the efficiency of soaking seed and foliar spraying of humic acid, fulvic acid, Imidacloprid (Gaucho) and combinations of them on the cotton pests, growth, yield, and yield components of Giza 86 cotton varieties. The results showed that Gaucho and Gaucho+ Humic+ Fulvic gave the high reduction percentage of *Thrips tabaci* and *Tetranychus urticae* when the cotton seed soaking with these compounds compared with control. On the other hand, the high reduction percentage of *Empoasca lybica* was recorded when the cotton plant treated with a foliar spray by Carbosulfan+ Fulvic acid and Carbosulfan+ Humic + Fulvic acid were 82.0 and 87.76 %, respectively during the two seasons. In addition, the reduction percentage of *Tetranychus urticae* was 84.15, 83.44 and 81.38% for Chlorfenapyr+ Fulvic acid; Chlorfenapyr+ Humic + Fulvic acid and Chlorfenapyr, respectively. The effect of Chlorfenapyr on the total number of true spiders on cotton was studied. Also, results indicated that Gaucho treatments increased the Plant height at harvest, Number of fruiting branches/plant, number of open bolls/plant and Seed cotton yield compared to control as well as a traditional pest control method. Thus, seed treatment of cotton crops with Imidacloprid can be an ideal strategy for IPM in the cotton field in Egypt.

INTRODUCTION

Cotton (*Gossypium barbadense* L.) is one of the most important crops grown in Egypt and many countries all over the world. The total cultivated area in Egypt was 132.000 feddans, produced about 96000 tons in season 2015/2016. The area increased to 336.000 fed., produced about 42600 tons in season 2017/2018 (Central Agency for public mobilization and statistic). Egyptian cotton is a major agricultural product that plays a prominent role in supporting the economy of the country. It is grown as a textile fiber, nutritive and animal feeding crop. Cotton is classified as a salt-tolerant crop, however, often adversely affected by soil salinity, especially during emergence and seedling growth (Ashraf, 2002).

Cotton plants are subjected to be attacked by several insects and mite pests, the most serious of which are the sucking pests, whitefly, jassid and thrips and mites are of considerable importance. Their attacks start from the beginning of the crop and continue till

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its maturity. No single pest control method is sufficient for good production. With effective control of cotton pests, the yield of cotton can be increased by 200-300 kg/ ha (Khan *et al*., 1987)

Tetranychus urticae Koch infests cotton fields nearly every year in Egypt and can be considered an important cause of lost revenue to cotton producers. This may be due to high reproductive potential and life cycle (Taha *et al.*, 2014). The tetranychid mites alone could cause a loss of 21% in cotton yield (Schwartz, 1985).

Cotton seedlings are most susceptible to thrips, *Thrips tabaci* (Lindeman) injury during the first 4 to 5 weeks after plant emergence. Feeding by thrips results in distortion, malformation and tearing of seedling leaves, reduced leaf area and plant height, reduced root growth, and injury to or death of the apical meristem, the latter of which leads to excessive vegetative branching. Plant maturity (i.e., fruit production) can be delayed and in extreme cases, losses of as much as 30–50% of lint yield potential have been reported (Cook *et al.*, 2001). Cotton Jassid *Empoasca lybica* (de Bergevin and Zenon) causes' leaves wilt and the edge of the leaf turn down and the leaf gives the inverted cup shape and burning the leaf edges. Jassid, thrips, whitefly and mites are major complications for increasing the yield and productivity of the crop. Jassid is reported to cause an 18.78% decline in cotton yield (Ali 1992). The threshold level of the infestation is 60 insects (adult and nymph)/ 100 leaves (Temerak, 2002).

The humic acid treatments on seed enhanced plant height, cottonseed yield. Also, the humic acid treatment of seed soaking + foliar spray increased the number of bolls and sympodial branches (Basbag, 2008). Humic acid in proper concentration can enhance plant and root growth (Ahmed *et al.*, 2013) Humic substances (humic, fulvic acid) attracts positive ions, forms chelates with micronutrients and releases them slowly when required by plants. According to (Kadam *et al.*, 2010), the humic substances act as chelating agents, thereby prevents the formation of precipitation, fixation, leaching and oxidation of micronutrients in the soil.

Fulvic acid as an organic fertilizer is a non-toxic mineral chelating additive and water binder that maximizes uptake through leaves and stimulates plant productivity (Malan, 2015). It attracts water molecules, helping the soil to remain moist and aiding the movement of nutrients into plant roots. Fulvic acid easily binds or chelates minerals such as iron, calcium, copper, zinc and magnesium, as it can deliver these elements to plant directly (Yamauchi *et al.*, 1984).

The aim of this study was to investigate the efficiency of soaking seed and foliar spraying of humic acid, fulvic acid, Imidacloprid (Gaucho), Carbosulfan, Chlorfenapyr and a combination of them for controlling the sucking insect pests and mites, growth, yield, and yield components of Giza 86 cotton varieties.

MATERIALS AND METHODS

Plant Material and Experimental Design:

Two field trials were conducted at El-Gemmeiza Agricultural Research Station, El-Gharbia Governorate, Egypt during the two successive seasons of 2018 and 2019, using the Egyptian cotton variety Giza 86 (*Gossypium barbadense*, L.). These experiments were conducted to study the effect of 15 treatments on cotton pests (*Thrips tabaci*, *Tetranychus urticae* and *Empoasca lybica)*, cotton growth, seed cotton yield and its components (Table 1).

A complete randomized block design with four replicates was used in both seasons, each plot (replicate) about 84 m^2. Sowing took place on April 7^{th} seeds of cotton cultivar “Giza 86” was shown in hills on one side of the ridge at the rate of 3-4 seeds per hill with 25 cm between hills. Two plants per hill were maintained by thinning at 25 days after sowing.

The other cultural practices were carried out as recommended for conventional cotton seeding in the local production district.

Table 1: Treatments and application rate

Treatments	Soaking seed	Foliar spray
Imidacloprid (Gaucho)	7g/kg seeds 24h. before sowing	-
Humic acid	10g/ 1liter 24h. hours before sowing	10gm/1liter water
Fulvic acid	10g/ 1 liter 24 h. before sowing	10gm/1liter water
Humic + Fulvic acid	(10+10) gm/1litre	(10+10) gm/1litre
Gaucho+ Humic acid	(7+10) gm/1litre	-
Gaucho + Fulvic acid	(7+10) gm/1litre	-
Gaucho+ Humic+ Fulvic	(7+10+10) gm/1litre	-
Carbosulfan+ Humic acid	-	(2 +10) gm/1litre
Carbosulfan+ Fulvic acid	-	(2 +10) gm/1litre
Carbosulfan+ Humic + Fulvic acid	-	(2+10+10) gm/1litre
Carbosulfan (Marshal 25% WP)	-	2 gm/ 1 liter
Chlorfenapyr (Challenger 24% Sc)	-	$2cm^3$/1 liter
Chlorfenapyr+ Humic acid	-	($2cm^3$+10gm)/1litre
Chlorfenapyr+ Fulvic acid	-	($2cm^3$+10gm)/1litre
Chlorfenapyr+ Humic + Fulvic acid	-	($2cm^3$+10gm+10gm)/1litre

The Study Included the Following Treatments:

Control treatment, 100% mineral fertilizer using recommended dose: 62 kg N ammonium nitrate (33.5% N); 30kg K_2O (superphosphate (15.5% P_2O_5) during land preparation) and 22 kg P2O5 /feddan (potassium sulfate (48% K_2O) in one dose after thinning).

For Seed Soaking: Humic acid and fulvic acid were applied with 10 gm/1litre and Gaucho applied at a rate of 7gm/1kg seeds as a soaking seed for 24 h before sowing. Samples of 10 seedlings of cotton were cut randomly in the early morning for each treatment. The seedling was inspected after 2, 3, 4 and 5 weeks after sowing seed soaking. The samples were transmitted to the laboratory and inspected by binocular microscope to count the movable stages of *T. urticae* and thrips.

The reduction percentages were calculated using the equation of (Abbott, 1925) formula:

$$\text{Reduction \%} = \left(1 - \frac{\text{No. of treated after spray}}{\text{No. of control after spray}}\right) \times 100$$

For Foliar Spray: Humic acid and fulvic acid were applied with 10gm/ 1 liter of water as a foliar spray after two months of sowing cotton. Samples of 25 cotton leaves were collected at random in the early morning from each treatment. The leaves were sampled directly before spray and 1, 2, 3 and 4 weeks after foliar spray. The two surfaces of the leaves were inspected carefully in the field using a lens (10X) to count the jassid adult stage. The inspected leaves were transmitted to the laboratory where a binocular microscope was used to count the movable stages of *T. urticae*. The reduction percentages were calculated using the equation of Henderson and Tilton (1955) formula: Reduction %= 100 * (1 - (Ta * Cb)/(Tb * Ca), where: Ta= number of mite after spray; Tb= number of mite before spray; Ca = the number of mite in the control after spray; Cb = number of mite in the control before spray.

Studied Characters:

A- **Growth Traits**: At harvest, data were taken from five random representative guarded hills from the second ridge of each plot to determine the following traits:

1- Plant height at harvest (cm).

2- Number of fruiting branches/ plant.

B- **Seed Cotton Yield and Its Components:**

At harvest, data were taken from five random representative guarded hills from each plot to determine the following yield components:

1- The number of open bolls per plant, as the average number of open bolls per plant, was calculated by counting the open bolls on the above ten representative plants before the first and the second pickings.

2- Average boll weight in grams: it was estimated as follows:

$$\text{Average boll weight (g)} = \frac{\text{Seed cotton yield per plant (g)}}{\text{No. of harvested open bolls per plant}}$$

3- Lint percentage:

The seed cotton-picking from the above ten representative plants was weighted and gained to obtain lint cotton. Lint percentage was calculated as follows:

$$\text{Lint percentage} = \frac{\text{Weight of lint cotton (g)}}{\text{Weight of seed cotton (g)}} \times 100$$

4- Seed index (weight of 100 cotton seeds in grams).

5- Seed cotton yield (kentar/fed):

Seed cotton yield of each plot in kilograms was recorded and transformed to kentars per feddan (one kentar = 157.5 kg).

Statistical Analysis:

The mean population of each insect per cotton leaf for all treatments was calculated and subjected to a one-way analysis of variance (ANOVA). Duncan's multiple range test (Duncan, 1955) was used to determine significant differences (P = 0.05) between treatments using (SAS, 2003).

RESULTS AND DISCUSSION

Humic compounds such as humic acid and fulvic acid have been shown to encourage plant growth in terms of increasing plant height and enhancing nutrient uptake. These effects seem to depend on the concentration and source of the substance and on the plant species. Humic and fulvic acids are the most characteristic compounds of soil humic substances. Humic substances are formed through the microbial degradation of plant material and the brown to black substances are the primary constituents of soil organic matter. Humic substances have the ability to hold seven times their volume in water, a greater water holding capacity than clay soils. Water stored within the topsoil enables plant roots to quickly access the available nutrients required for plant growth and yield.

Seed Soaking:

1-Cotton Thrips, *Thrips tabaci*

Thrips infested cotton crops causing rust appearance from a distance. It is a vector of yellow spot virus and spotted wilt virus. Humic acid and fulvic acid were applied with 10 gm/1litre and Gaucho applied at a rate of 7gm/1kg seeds as a soaking seed for 24 h before sowing. The efficacy of Imidacloprid seed treatment against sucking pest incidence on cotton cultivar under field condition is presented in (Table 2). The Imidacloprid (Gaucho) seed treatments showed a significantly lower incidence of Thrips on treatments Gaucho, Humic + Fulvic acid, Gaucho+ Humic acid, Gaucho + Fulvic acid and Gaucho+ Humic+ Fulvic than those on the untreated control ($F= 6.19$, $p < 0.0001$) in the first season 2018. The efficacy of the seed treatments showed that the reduction percentage was 90.16, 80.64, 86.88, 78.32 and 80.82%, respectively. While in the second season 2019 non-significant differences between treatments ($F=1.19$, $P= 0.351$) the reduction percentage ranged from 72.98 to 83.46% than of control. The highest general mean reduction during the two seasons was recorded for Gaucho, Gaucho+ Humic acid, Gaucho+ Humic+ Fulvic and Gaucho + Fulvic acid were 86.47, 84.07, 82.14 and 78.83%, respectively, followed by Humic + Fulvic acid, Humic acid and Fulvic acid recorded 77.54, 66.34 and 69.63%, respectively.

Our results are also in accordance with that of Patil *et al*., (2003), who showed that seed treatment with Imidacloprid reduced the sucking pest population below the economic threshold level up to 40 days after sowing. Hossain, *et al.*, 2012 indicated that Imidacloprid, Gaucho70 WS as a seed dresser may be an option for controlling sucking pests of cotton under field conditions. Asif *et al.*, 2016 showed that a significant difference in the mean reduction percentage of thrips after 1, 3 and 7 days of two applications by Imidacloprid was 66.30, 70.61 and 68.51; 68.58, 69.98 and 70.35%, for the first and second application, respectively. The chemical control of Thrips includes the seed treatment with an insecticide before plantation or spray insecticide in the infected area. For seed treatment, the professional recommendation in agriculture pest control recommends the use of Gausho 70% WS with the rate of 7 gm/kg of seed (El-Wakeil and Abdallah, 2012).

Table 2: Reduction percentage of individuals *Thrips tabaci* and *Tetranychus urticae* infesting cotton plants after treating with Imidacloprid (Gaucho) and seed soaking with Humic and Fulvic acids under field condition during season 2018 and 2019**.**

Treatments	Rate of application	Reduction percentage of pests /10 seedlings after 5 weeks of the application					
		Thrips tabaci			*Tetranychus urticae*		
		2018	2019	Mean R.%	2018	2019	Mean R.%
Imidacloprid (Gaucho)	7gm/1kg seed	90.16 a	82.77 a	86.47 a	82.89 a	83.18 a	83.04 a
Humic acid	10 gm/1litre	59.69 b	72.98 a	66.34 c	57.74 b	67.26 c	62.50 bc
Fulvic acid	10 gm/1litre	64.41 b	74.84 a	69.63 bc	55.74 b	64.51 c	60.13 c
Humic + Fulvic acid	(10+10) gm/1litre	80.64 a	74.43 a	77.54 ab	67.10 b	71.09 bc	69.10 b
Gaucho+ Humic acid	(7+10) gm/1litre	86.88 a	81.25 a	84.07 a	85.31 a	78.48 ab	81.90 a
Gaucho + Fulvic acid	(7+10) gm/1litre	78.32 a	79.34 a	78.83 a	82.19 a	78.23 ab	80.21 a
Gaucho+ Humic+ Fulvic	(7+10+10) gm/1litre	80.82 a	83.46 a	82.14 a	84.85 a	83.15 a	84.00 a
F-value		6.19	1.19	5.53	6.95	5.24	11.63
Probability		0.0001	0.351	0.0002	0.0004	0.0020	0.0001
LSD at level 5%		13.29	11.63	9.0	14.66	9.68	8.54

Different letters in same column denote significant difference ($P < 0.05$).

2-Two-Spotted Spider Mite, *T. urticae*

The nutritive acids humic acid an fulvic acid and Imidacloprid separately and the binary mixtures of the nutritive acids with the insecticides were tested for their insecticidal activity against *T. urticae* on cotton plants under the field conditions. It is noticed from the data presented in (Table 2). Showed that the population density of *T. urticae* after two weeks of soaking seeds ranged from 2 to 57 mites per 10 cotton seedlings in season 2018 and from 19 to 150 mites per 100 cotton seedlings in season 2019 after 5 weeks of application.

Accordingly, the equation of Abbott (1925) was used to calculate the corrected percent reduction that occurred in *T. urticae* infestation as a result of the application of the tested compounds in relation to the untreated check. A highly significant reduction percentage was observed between treatments and control during the two seasons. The redaction percentage ranged from 55.74 to 85.31% in the first season, whereas it ranged from 64.5 to 83.18% in the second season 2019. The general mean reduction during the two seasons was 84.0 in Gaucho+ Humic+ Fulvic followed by 83.04% for Gaucho, while the lowest reduction was 60.13% for Fulvic acid after 5 weeks of application.

The results of this study showed that Imidacloprid seed treatments effectively reduced *T. urticae* and thrips inhabitants in the cotton field, as well as the combination of Humic acid and Fulvic acid, gave a high reduction after 5 weeks of application during the two seasons. These results agree with the finding by Patil *et al*., (2003), who found that seed treatment with Imidacloprid reduced the sucking pest population below the economic threshold level up to 40 days after sowing. Also, Eziah *et al.*, 2016 showed that *T. urticae* population from all the fields was susceptible to Imidacloprid except the Opeibea population which recorded a 9.0-fold resistance.

Foliar Spray:

1-Jassids (*Empoasca lybica*)

The presented data (Table 3) showed that application of individuals Jassids (*Empoasca lybica*) infesting cotton plants after treated with Carbosulfan (Marshal 25% WP) and foliar spray with Humic, Fulvic acids and a combination of them after two months of sowing cotton under field condition during season 2018 and 2019.

Table 3: Reduction percentage of individuals Jassids (*Empoasca lybica*) infesting cotton plants after treating Carbosulfan and foliar spray with Humic and Fulvic acids under field condition during season 2018 and 2019.

Treatments	Rate of application	Reduction percentage of pests /25 leaves after 4 weeks		
		Empoasca lybica		
		2018	2019	Mean R.%
Carbosulfan (Marshal 25% WP)	2 gm/ 1 liter	81.29 bc	81.53 ab	81.40 b
Humic acid	10 gm/1litre	77.10 cd	61.56 c	69.33 c
Fulvic acid	10 gm/1litre	79.58 bc	61.06 c	70.32 c
Humic acid + Fulvic acid	(10+10) gm/1litre	74.53 d	55.64 c	65.08 c
Carbosulfan+ Humic acid	(2+10) gm/1litre	83.65 b	73.16 b	78.40 b
Carbosulfan+ Fulvic acid	(2+10) gm/1litre	84.20 b	79.81 ab	82.0 ab
Carbosulfan+ Humic + Fulvic acid	(2+10+10) gm/1litre	92.48 a	83.04 a	87.76 a
F-value		11.7	14.70	16.26
Probability		0.0001	0.0001	0.0001
LSD at level 5%		5.0	8.64	5.78

Different letters in same column denote significant difference ($P < 0.05$).

In the First Season 2018:

A sample of 25 leaves per treatment was collected randomize. From the data demonstrated in (Table, 3), it was found that the highest reduction percentage was 92.48% for Carbosulfan+ Humic + Fulvic acid at a rate (2+10+10) gm/1litre after four weeks of application. Followed by Carbosulfan+ Fulvic acid; Carbosulfan+ Humic acid and Carbosulfan with a reduction of 84.20; 83.65 and 81.29 % in the first season respectively. The lowest reduction of the jassid population was 74.53% for Humic acid + Fulvic acid at a rate of (10+10) gm/1litre during the first season.

In the Second Season 2019:

Similar results in (Table 3) showed that all the tested compounds significantly decreased the number of jassid in an irregular way compared to the untreated control. Results also cleared that all compounds caused a decrease till 4 weeks after application.

The highest mean reduction percentages of jassid were 83.04, 81.53 and 79.81 for Carbosulfan+ Humic + Fulvic acid, Carbosulfan and Carbosulfan+ Fulvic acid in the second season 2019, respectively without significant differences among them. Whereas the general mean during the two seasons were 81.40, 69.33, 70.32, 65.08, 78.40, 82.0 and 87.76% for Carbosulfan, Humic acid, Fulvic acid, Humic acid + Fulvic acid, Carbosulfan+ Humic acid, Carbosulfan+ Fulvic acid and Carbosulfan+ Humic + Fulvic acid, respectively. These results are in agreement with those obtained (Temerak, 2002), the infestation occurs after 45 days from the plantation date. The control could be done using the chemical insecticides following the ministry of agriculture recommendations. Razaq *et al.* (2005) studied the efficacy of conventional insecticides on the cotton crop during the 2002 and 2003 season against cotton jassid, Diafenthiuron, acetamiprid, Imidacloprid and thiamethoxam proved to be the most effective in reducing jassid population. Hossain, *et al.*, 2012 showed that Imidacloprid seed treatments effectively reduced aphid, whitefly and thrips inhabitants in the cotton field of Bangladesh. Both fuzzy and delineated seeds exhibited higher efficacy against the sucking pests in the field conditions. El–Dewy and El – Zahi (2018) showed that humic acid was the most effective nutritive acid against *Aphid gossypii* with a 42.21% mean of reduction. With respect to the binary mixtures of pesticides with boric acid, humic acid and fulvic acid, slight and insignificant decreases were found in the activity of the mixtures comparing to the insecticides applied alone. Asif *et al.,* 2016 showed that the mean reduction percentage of jassid was 50.0 and 42.06% after 7 days of two applications on cotton plants. The insecticides Marshal 25% EC (Carbosulfan) at a rate of 100 ml/100-liter water reduced thrips populations compared to controls, the general mean reduction was 68.54% after two application during the two-season (Elhalawany *et al.,* 2019).

1-Two-spotted Spider Mite, *T. urticae*:

The effectiveness of experimented compounds on population density and reduction percentages of the *T. urticae* infesting cotton under field conditions. The foliar spray of 7 compounds was Chlorfenapyr (Challenger), Humic acid, Fulvic acid, Humic acid + Fulvic acid, Chlorfenapyr+ Humic acid, Chlorfenapyr+ Fulvic acid and Chlorfenapyr+ Humic + Fulvic acid after two months of sowing.

The results in (Table 4) showed that all the treatments significantly reduced *T. urticae* population in comparison with untreated control. The results also indicated that all compounds continued to affect the process of reducing the incidence of pest till the experiment end 4 weeks after application.

Table 4: Reduction percentage of individuals *Tetranychus urticae* infesting cotton plants after treating Chlorfenapyr and foliar spray with Humic and Fulvic acids under field condition during season 2018 and 2019.

Treatments	Rate of application	Reduction percentage of pests /25 leaves after 4 weeks		
		Tetranychus urticae		
		2018	2019	Mean R.%
Chlorfenapyr (Challenger)	$2cm^3$/1 liter	76.93 ab	85.84 a	81.38 ab
Humic acid	10 gm/1litre	72.57 b	80.68 b	76.62 bc
Fulvic acid	10 gm/1litre	74.22 ab	74.18 c	74.20 c
Humic acid + Fulvic acid	(10+10) gm/1litre	74.15 ab	71.54 c	72.84 c
Chlorfenapyr+ Humic acid	($2cm^3$+10gm)/1litre	78.58 ab	71.88 c	75.23 c
Chlorfenapyr+ Fulvic acid	($2cm^3$+10gm)/1litre	81.46 a	86.85 a	84.15 a
Chlorfenapyr+ Humic + Fulvic acid	($2cm^3$+10gm+10gm)/ 1litre	80.47 ab	86.41 a	83.44 a
F-value		1.35	21.07	6.18
Probability		0.278	0.0001	0.0001
LSD at level 5%		8.62	4.47	5.30

Different letters in same column denote significant difference (P < 0.05).

In the first season 2018 results in (Table 4) show that all the treatments gave high reduction according to the initial effect of the acaricide: Chlorfenapyr+ Fulvic acid was at a rate (2+10) gm/1litre the most effective treatment, while the non-significant difference between the other compounds. The lowest reduction percentage was 72.57% for Humic acid at a rate of 10 gm/1litre in the first season.

In the second season, effectively reduced populations density of *T. urticae* after four weeks post-treatment to 73, 195, 170, 151, 56, 45 and 54, whereas reduction percentages were 85.84, 80.68, 74.18, 71.54, 71.88, 86.85, and 86.41% for Chlorfenapyr, Humic acid, Fulvic acid, Humic acid + Fulvic acid, Chlorfenapyr+ Humic acid, Chlorfenapyr+ Fulvic acid and Chlorfenapyr+ Humic + Fulvic acid, respectively. While the general mean reduction percentage during the two seasons were 81.38, 76.62, 74.20, 72.84, 75.23, 84.15 and 83.44%, for the same treatments, respectively. Statistical analysis showed a significant difference between general effects percentages of the compounds examined.

From the above-mentioned data, the feeding damage of spider mites, concentrated primarily on the lower surface of the leaves. The heavy infestation, severe defoliation occurs and leaves become entirely gray, curl, turn brown, and drop off. This decreases the photosynthetic capacity of plants, (Wilson *et al.,* 1991). Our findings also agree with the results of El-Ghobashy and El-Sayed (2002) indicated that Challenger 36% SC gave a reduction in the population density of the mite pest *T. arabicus* attiah which averaged 92.60%. Hossain, *et al.,* 2012 indicated that cotton plants grown with Imidacloprid treated seeds have abundances of ladybird beetles, lacewings, syrphids and spiders. The cotton cultivar produced a significantly higher yield when seeds were treated with Imidacloprid at 5.5g/ kg fuzzy seed. Saleh *et al.,* 2019 showed that significant reduction in the population of *T. urticae* on the pepper plant, in the first and second seasons which recorded 64.16 and 66.85% respectively.

1-Dominant Spider Families on Cotton Plants:

Spiders are considered one of the most important natural control agents in a wide range around the world. Field trials were conducted in Gharbia Governorate during 2018 to study the incidence of the dominant true spider families on cotton crops treated with chlorfenapyr and foliar spray with Humic and Fulvic acids and a combination of them. Data regarding the population of spider families in (Table 5) demonstrate that recorded predacious spiders were identified in 6 families as follows: Philodromidae (crab spiders), Theridiidae (cobweb spider), Araneidae (orb-weaver spider), Salticidae (jumping spiders), Linyphiidae (a money spider) and Lycosidae (wolf spider).

The results of the spider populations associated with cotton showed that, chlorfenapyr and foliar spray with Humic and Fulvic acids foliar spray treatments significantly reduced spider population, compared to control and treatment groups ($F = 3.54$, $p < 0.0028$), it was recorded 15.83, 44.50 and 39.17 individuals during season 2018, respectively, while it was recorded 69.5 individuals in control. The present study showed that spider abundances on the cultivar were positively correlated with the abundances of prey. These results agree with the finding by Hossain, *et al.,* 2012 revealed that ladybird beetles, lacewings, syrphids and spiders were abundant on cotton plants that were grown from the seeds treated with Imidacloprid. Abu-Zaed, 2019 record on faba bean in Beni-Suef Governorate during 2017 and 2018 seasons, 6 spider families Uloboridae Theridiidae, Salticidae, Thomisidae, Philodromidae and Mimetidae. Also indicated that, The high percentage mortality appeared in different species spider treated with the recommend of Chlorfenapyr, 36% SC after 7 days

Table 5: Total number of some dominant spider families on cotton plants after treating with chlorfenapyr and spray with Humic and Fulvic acids under field condition during 2018 season.

Spider families	No. spider families							Control
	Chlorfenapyr	Humic acid	Fulvic acid	Humic acid + Fulvic acid	Chlorfenapyr + Humic acid	Carbosulfan + Fulvic acid	Chlorfenapyr + Humic acid +Fulvic acid	
Philodromidae	33	78	69	75	82	85	59	95
Theridiidae	22	65	48	55	61	66	74	88
Araneidae	12	54	47	64	59	48	58	78
Salticidae	9	34	34	36	45	57	78	65
Linyphiidae	8	22	18	24	27	22	25	36
Lycosidae	11	14	19	43	33	46	64	55
Total	**95**	**267**	**235**	**297**	**307**	**324**	**358**	**417**
Mean	15.83^{c}	44.50^{b}	39.17^{b}	49.50^{ab}	51.17^{ab}	54.0^{ab}	59.67^{ab}	69.50^{a}
F-value	3.54							
L.S.D. at 5%	23.20							

.

Effect of Treatments on Yield and Yield Components of Giza 86 Cotton Variety:

A- Growth Traits:

1-Plant Height at Harvest (cm);

Data in Table (6) indicated that Gaucho, Humic acid (seed soaking), Fulvic acid (seed soaking) and Humic + Fulvic (seed soaking) for Giza 96 had a significant effect on plant height at harvest during the first season 2018. While in the second season Gaucho and Humic acid (seed soaking) had a significant effect on plant height. These results indicated that Gaucho and Humic acid (seed soaking) gave the highest plants in the two seasons. On the contrary, the fulvic and humic spray gave the shortest plants in the two seasons.

2-Number of Fruiting Branches/ Plant:

Data in Table (6) revealed that no. of fruiting branches were affected significantly by treatments in the first season, while non-significant in the second season. The treatment of Gaucho gave the highest values of sympodia per plant 19.1, followed by Humic acid (seed soaking), Fulvic acid (seed soaking) and Humic + Fulvic (seed soaking) was 13.9, 13.8 and 13.8 in the first season 2018. On the other hand, the lowest values of sympodia on the main stem (13.2 and 12.0), were recorded from the Fulvic acid (spray) and the fulvic and humic spray, respectively.

b- Seed Cotton Yield and Its Components:

At harvest, data were taken from five random representative guarded hills from each plot to determine the following yield components:

1-The Number of Open Bolls Per Plant:

The average number of open bolls per plant was calculated by counting the open bolls on the above ten representative plants before the first and the second pickings. The open boll of the inspected Giza 86 cotton cultivar in the two experimental seasons was statistically significant in both seasons, and represented in Table (6). The results indicated that the treatment of Humic acid (seed soaking), Fulvic acid (seed soaking) and Humic + Fulvic (seed soaking) gave the highest no. of open bolls/ plants in the first season, while the application of Gaucho, Humic acid (seed soaking), Fulvic acid (seed soaking) and Humic + Fulvic (seed soaking) gave the highest no of open bolls/ plants in the second season 2019. On contrary, the lowest no. of bolls was recorded for humic+ fulvic spray in the two seasons.

2-Average Boll Weight in Grams:

The boll weight of the inspected Giza 86 cotton cultivar in the two experimental seasons was statistically significant in both seasons in Table (6).

The results showed that Gaucho, Humic acid (seed soaking), Fulvic acid (seed soaking) and Humic + Fulvic (seed soaking) gave the highest boll weight during the two seasons it ranged from 3.1 to 3.3 gm.

3-Lint Percentage:

Data in Table (6) indicated that all applications for Giza 96 cotton variety had a significant effect on the lint percentage than humic+ fulvic spray which gave the lowest value of lint percentage 39.6 and 38.8 in the two seasons, respectively.

4-Seed Index (weight of 100 cotton seeds in grams):

The influence of treatments applied during the study of this character was given in Table (6) Seed index values were affected significantly by the application of the studied fertilizer treatments during the two seasons. Gaucho gave the largest values of seed index (10.9 and 10.7) in the first and second year, respectively. While no-significant differences between the other treatments during the two seasons.

Table 6: Effect of the tested treatments on yield and yield components of Giza 86 cotton variety

Treatments	Plant height at harvest (cm)		No. of fruiting branches / plant		No. of open bolls / plant		Boll weight (gm)		Seed index		lint %		Seed cotton yield (kentar/ fed.)	
	2018	2019	2018	2019	2018	2019	2018	2019	2018	2019	2018	2019	2018	2019
Control	127.3^{b}	129.9^{c}	14.8^{b}	15.1	25.2^{a}	25.7^{a}	3.3^{a}	3.2^{a}	10.1^{b}	10.3^{a}	41.5^{a}	40.7^{a}	9.6^{b}	9.7^{b}
Gaucho	183.9^{a}	171.2^{a}	19.1^{a}	16.3	23.1^{b}	25.0^{a}	3.3^{a}	3.1^{a}	10.9^{a}	10.7^{a}	39.7^{a}	40.8^{a}	11.3^{a}	11.0^{a}
Humic acid (seed soaking)	127.0^{b}	139.5^{b}	13.9^{b}	14.2	25.4^{a}	25.7^{a}	3.2^{a}	3.2^{a}	9.9^{c}	10.1^{b}	40.9^{a}	40.0^{a}	9.4^{b}	9.6^{b}
Fulvic acid (seed soaking)	123.7^{b}	126.1^{c}	13.8^{b}	14.1	24.2^{a}	24.7^{a}	3.2^{a}	3.1^{a}	9.9^{c}	10.1^{b}	40.7^{a}	39.9^{a}	9.2^{c}	9.4^{c}
Humic + Fulvic (seed soaking)	121.0^{b}	123.4^{c}	13.8^{b}	14.0	24.0^{a}	24.5^{a}	3.2^{a}	3.1^{a}	9.9^{c}	10.1^{b}	40.8^{a}	40.0^{a}	9.0^{c}	9.1^{d}
Humic acid (spray)	119.0^{c}	121.4^{d}	13.7^{b}	14.0	23.2^{b}	23.6^{b}	3.1^{b}	3.1^{a}	9.8^{c}	10.0^{b}	40.2^{a}	39.4^{a}	8.9^{c}	9.1^{d}
Fulvic acid (spray)	115.7^{c}	118.0^{d}	13.2^{c}	13.5	22.7^{b}	23.1^{b}	3.1^{b}	3.1^{a}	9.8^{c}	10.0^{b}	40.2^{a}	39.4^{a}	8.4^{d}	8.6^{e}
Humic + Fulvic (spray)	114.0^{c}	116.3^{d}	12.0^{c}	12.3	21.0^{c}	21.6^{c}	3.0^{b}	3.0b	9.5^{c}	9.7^{c}	39.6^{b}	38.8^{b}	7.8^{e}	8.0^{f}
L.S. D	**8.11**	**8.27**	**1.52**	**15.5**	**1.51**	**1.54**	**0.17**	**0.16**	**0.40**	**0.41**	**1.89**	**1.85**	**0.16**	**0.17**

5-Seed Cotton Yield (kentar/fed):

The seed cotton yield of each plot in kilograms was recorded and transformed to kentars per feddan. Statistical analysis of the data in Table (6) revealed that seed cotton yield (seed +cotton fiber) (Kentar/fed.) significantly in the two seasons. The application of Gaucho gave the maximum seed cotton yield kg/fed. (11.3 and 11) in the first and second year, respectively, followed by humic acid (seed soaking) (9.4 and 9.6. on the other hand, humic+ fulvic acid (spray) gave the lowest seed cotton yield (7.8 and 8.0 Kg/ fed.) in the first and second year, respectively.

Our findings also agree with the results of EL- Tabbakh (2002) reported that the number of bolls /plant and seed cotton yield per plant were higher when treated with insecticides, Actellic, Durspan and Larvin. Basbag (2008) found that humic acid applications (seed soaking, foliar spray, seed soaking + foliar spray) affected total cottonseed yield. Temz *et al.* (2009) found that different humic acid treatments (seed soaking, foliar spray, seed soaking + foliar spray) insignificantly affected seed cotton yield as compared with the untreated control application of humic acid. However, Hamoda (2012) found that lint % was insignificantly effected by the humex treatments. The tallest cotton plants were produced due to foliar spraying of humex 5 cm^3/L three times, while the shortest plants were produced from untreated plants (control treatment) in both seasons of study. Also, found that the highest values of a number of sympodia/plant were obtained from the application of humex, while the lowest values were obtained from untreated plants (control) in both seasons of study. Hossain, *et al.,* 2012 showed that Imidacloprid treatment kept the cotton plants free from severe insect infestation, thus the normal vigor of the plants was not hampered and produced a higher yield compared to untreated control. Asif, *et al.*, 2016 indicated that maximum seed cotton yield (2.99 tons/ ha) was recorded in Imidacloprid treated plots.

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ARABIC SUMMARY

تأثير نقع البذور والرش الورقي لحمض الهيوميك وحمض الفولفيك على آفات محصول القطن، مقارنة ببعض المبيدات الموصى بها

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معهد بحوث وقاية النباتات- مركز البحوث الزراعية- الدقى -جيزة

تم إجراء تجربتان حقليتان في محطة الجميزة للبحوث الزراعية بمحافظة الغربية بمصر خلال موسمي 2018 و2019. وكان الهدف من هذه الدراسة هو دراسة تأثير نقع البذور والرش الورقي لحمض الهيوميك وحمض الفولفيك، ومركب الجاوشو ومخاليطها على آفات القطن والنمو والمحصول ومكوناته على صنف قطن الجيزة 86. أظهرت النتائج أن جاوشو والجاوشو+ الهوميك+ الفولفك أعطت نسبة أعلى نسبة خفض فى تعداد تربس القطن والعنكبوت الأحمر عند نقع بذور القطن بهذه المركبات مقارنة مع الكونترول. من ناحية أخرى، سجلت أعلى نسبة خفض لحشرة الجاسيد عندما تم رش نبات القطن بالرش الورقي بواسطة (مارشال+ وحمض الفولفك) و (الهيومك+ مركب مارشال + حمض الفولفيك)82.0 و87.76٪ على التوالي خلال الموسمين. بالإضافة إلى ذلك، كانت نسبة الخفض للعنكبوت الأحمر العادي 84.15، 83.44، 81.38% الشالنجر+ الفولفك، والشالنجر والفولفك والهيومك ثم الشالنجر على التوالي. تم دراسة تأثير الشالنجر على تعداد العناكب الحقيقة على القطن. كما أشارت النتائج إلى أن معاملات الجاوشو أدت إلى زيادة ارتفاع النبات عند الحصاد، وعدد الأفرع الثمرية / نبات، وعدد اللوز المكشوف / نبات، ومحصول القطن البذري مقارنة بالطريقة الآخرى والطريقة التقليدية لمكافحة الآفات. وبالتالي فإن معالجة بذور محاصيل القطن باستخدام الجاوشو يمكن أن تكون استراتيجية مثالية للمكافحة المتكاملة للآفات على محصول القطن في مصر.