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IMPACT OF GARLIC EXTRACT IN COMPARISON WITH CHLOROPYRIFOSE INSECTICIDE AGAINST CERTAIN PESTS AND ASSOCIATED PREDATORS IN COTTON FIELDS AT SHARKIA GOVERNORATE, EGYPT

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ABSTRACT: Field experiments were conducted in cotton fields, *Gossypium barbadense* L. variety Giza 86 at Zagazig District, Sharkia Governorate, Egypt during 2014 season. Four programs were applied with three respective sprays for each using commercial formulation of garlic extract Nat-108 and varied as spray start times and interval periods towards the development of more environmentally sound technologies for management of cotton aphids (*Aphis gossyppii*), cotton thrips (*Thrips tabaci*), sweet potato whitefly (*Bemesia tabaci*), spider mites (*Tetranychus* spp.), leafhoppers (*Empoasca* spp.), green stink bug (*Nezara viridula*), pink bollworm (*Pectinophora gossypiella*) and cotton leafworm (*Spodoptera littoralis*). In addition to the side effects on several predators species found in cotton fields associated with cotton pests, such as, coccinellids, chrysopids, staphylinids, anthocorid, dipterous and true spiders were studied. Results, educed that the commercial formulation of garlic extract at the rate of 1 litter/100 litter water showed relatively high efficiency against aphids, leafhoppers and thrips, with maximum reduction percentages of 81.33, 82.51 and 84.12%, respectively; moderate efficiency against pink bollworm, whitefly, spider mites, green stink bug with maximum reduction percentages of 61.50, 78.89, 67.56 and 54.46%, respectively and low efficacy against predators except at the end season where the relatively highest reduction percentage was 62.91%, while it was less effective against the cotton leaf worm ranged 23.30-25.80% reduction in comparison with 70.56-90.00% reduction in cotton leafworm population for Dursban (chloropyrifose). So, the garlic extract cannot considered as a botanical pesticide against *S. littoralis* under cotton field conditions at Sharkia Governorate but needs more studies to evaluate its efficacy on different levels of *S. littoralis* infestation and stags. In regard to the programs results for garlic extract efficacy, it cleared that the first program tended to be the highest sustainable control of aphids, whitefly, thrips and spider mites on cotton plants, where the sprays started just after cotton plants emergence, whereas the numbers of pests were very low while the third program where the sprays started after 20 days of cotton plants emergence was tended to be the highest sustainable control of leafhoppers. In case of *N. viridula*, it could be decided that the organophosphorous pesticide, Dursban can be used as effective insecticide especially at the end season period. Finally, garlic extract was tended to be safe to predators especially throughout its effective activity period during the period from seedling to the end of growing season of cotton plants that confirmed by the results of the third program which ranged 2.57-21.46% reduction percentages in predators population. So, garlic extract could be recommended to be used effectively against cotton aphids, leafhoppers, cotton thrips and pink bollworm in IPM program of cotton pests in cotton fields. The organophosphorous compound, Dursban can be considered as good control pesticide against tested pests recorded reduction percentages ranged 56.99-96.99% but caused serious damage to associated predators on cotton plants at the end of season period recorded reduction percentages reached to 99.76% that disturbed the natural balance in cotton cultivation area environment.

Key words: Garlic extract (Nat-108), chloropyrifose, cotton pests, spraying program.

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INTRODUCTION

In Egypt, cotton is subject to be attacked by several pests. The piercing- sucking pests, cotton bollworm and cotton leaf worm are the key economical important pests affecting cotton plants (*Gossypium barbadense* L.) production. The piercing- sucking pests suck cell contents of infested plants while feeding, exert huge amounts of honeydew that eventually promotes development of sooty mould, which reduces the photosynthetic efficiency of the plant (Jazzar and Hammad, 2003). Severe infestation can lead to reduce plant vigor and growth, chlorosis, uneven ripening or reduce crop yield (Hammad *et al*., 2000). The pink bollworm, *Pectinophora gossypiella* (Saund.) and cotton leafworm, *Spodoptera littoralis* (Boisd.) are the most distinctive pests infested cotton plants. The larvae of cotton leafworm destroy all aerial plant parts, leaves, buds, squares and bolls. The larvae of pink bollworm destroy the squares, render boll value less, eat the content of the seed and prevent the lint from reaching full development (Douglas *et al*., 1992). Several predators' species are found in cotton fields associated with cotton pests, such as, coccinellids, chrysopids, staphylinids and true spiders; the role of these predators is highly significant against cotton pests (Ibrahim, 2001). In Egypt, pesticides are used extensively in cotton fields to enhance yield and controlling harmful pests, the most cotton pests become tend to be resistant to many used pesticides (including several groups) and insect growth regulators. Hence, considerable efforts has been made towards the development of more environmentally sound technologies for management of these pests (Jazzar and Hammad, 2003). However, garlic extract has insecticidal properties (Ho *et al*., 1996) and shows considerable toxicity and repellency to number of pest species. The garlic extract is not as effective and fast acting as synthetic pesticides can be, but it is safe for environment, bio-enemies and consumers of cotton products.

The organophosphorous compound, Dursban (chloropyrifose) was considered as common pesticide used in cotton fields for long time to control several cotton pests with high efficacy against lepidopterous insects and good efficacy against other pests like aphids and leafhoppers, while it was less effective against white fly (Ibrahim, 2001)

Therefore, the purpose of this paper is to establishment garlic extract in cotton integrated pest management program by evaluate the efficacy of this natural plant extract in controlling piercing-sucking pests, pink bollworm and cotton leafworm in comparable with Dursban at different infestation levels and different cotton growing stages in addition to the side effects on predators associated with cotton pests.

MATERIALS AND METHODS

Experimental Design

Field experiments were conducted in cotton field planted on 10th of April during 2014 growing season with cotton, *G. barbaden*se variety Giza 86 at Zagazig District (Sharkia Governorate) (East-northern Egypt). The three experiments were carried out as follows:

Piercing-sucking pests and associated predators experiment

The experimental area treated to evaluate the efficacy of tested compound (garlic extract, Nat-108) at early and end season programs compared with Dursban, chloropyrifose only at end season program) against piercing-sucking pests and associated predators was divided to plots each = 1/100 fad. (42 m^2) and each replicated three times for treated and untreated plots.

The target piercing-sucking pests were, cotton aphids (*A. gossyppii*), cotton thrips (*T. tabaci*), sweet potato whitefly (*B. tabaci*), spider mites (*Tetranychus* spp.), leafhoppers (*Empoasca* spp.), and green stink bug (*N. viridula*). In addition to the side effect on several predators species found in cotton fields associated with the cotton pests, such as, coccinellids, chrysopids, staphylinids, anthocorid, dipterous and true spiders.

All plots were received normal agricultural practices during the experimental interval. The treated and untreated plots were arranged as a complete randomized blocks design. The application programs were sprayed just after emergence, 10, 20 days of emergence with garlic extract where at the end of season the

application programs used garlic extract and Dursban. In each of previous programs three sprays were applied after 1, 2 and 3 week intervals. Nat-108 50% garlic extract and Dursban 48% EC were sprayed at the rate of 1 litter and 250 ml/100 litter water, respectively.

Pink bollworm and cotton leaf worm experiments

Experimental area treated to compare the efficacy of tested compounds (garlic extract and Dursban) against pink bollworm, *P. gossypiella* in seven plots and cotton leafworm, *S. littoralis* in three plots. Each plot of 1050 m^2 was divided to three replicates each was 350 m^2 for treated and untreated treatments. Each of tested compounds, garlic extract 50% used at rate of 1 litter/100 litter water and Dursban, 48% EC (chloropyrifose) used at rate of 250 ml/100 litter water was sprayed in seven plots for *P. gossypiella*, the first plot of each compound was sprayed three times with one week interval; the second plot of each compound was sprayed three times with two weeks interval; the third plot of each compound was sprayed three times with three weeks interval for pink bollworm and the sprays started on mid-July and up, while in case of cotton leaf worm the tow treated plots were sprayed one time on early June. All plots were received normal agricultural practices.

Sampling Technique

Piercing-sucking pests

Sampling times plan

The numbers of considered piercing-sucking pests were estimated just before applications and after 2, 5, 10, 15 and 20 days after application as spraying program and sprays interval time. Initial effect of the used extract was estimated five days after application while it conducted after two days for the conventional insecticide, chloropyrifose. Accumulated residual effect was also estimated for the counting carried out after 10, 15 and 20 days from application as spraying program and sprays interval time and compounds variation, then the averages of reduction percentages were calculated and tabulated as well as untreated.

Sample size

Number of aphids, whitefly, thrips, spider mites was counted on 10 randomly selected seedlings/replicate (30 seedlings/treatment), early in the season until true leaves formation, then 10 leaves/rep. were taken. Populations of leafhoppers and green stink bug were estimated by counting insects obtained by 10 sweeps (using 38-cm diameter sweeping net) from the central rows of each plot.

Predators associated with cotton plants

The numbers of several predators species found in cotton fields associated with the cotton pests, such as, coccinellids, chrysopids, staphylinids and true spiders, *Chrysoperla carnea, Coccinella* spp., were estimated as visual count technique on 10 plants/rep. throughout whole season.

Cotton leaf worm

Picking up of egg masses was stopped, after 5 days, the numbers of larvae/100 plants were counted before application and after 3, 5, 7 and 9 days of application in treated and control plots.

Pink bollworm

A sample of 100 green cotton bolls was taken randomly and examined before application and weekly after application in treated and untreated plots.

Generally the reduction percentages of population for each pest species and total numbers of predators were calculated according to the formula of Henderson and Tilton (1955). The averages of reduction (%) of initial and residual effect were deduced for all treatments.

Statistical Analysis

The obtained results were submitted to analysis of variance as three ways completely randomized design for the data of aphids, whitefly, thrips, leafhoppers, spider mites and predators. The data of green stink bug was submitted to analysis of variance as two ways completely randomized blocks design using Little and Hills (1978).

RESULTS AND DISCUSSION

Cotton Pests

The obtained results in Tables 1, 2, 3, 4, 5 and 6 show that all examined pests were affected negatively by different garlic extract treatments, while the effects were varied as pest and application programs variation as well as the predators associated with cotton pests which were affected but in lower levels at all tested programs except at end season. The resulted data of garlic extract effects on investigated pests and predators associated with cotton pests were discussed as follows:

Cotton aphids, *Aphis gossypii* Glov.

Tabulated results in Table 1 cleared that the numbers of aphids were significantly reduced in garlic extract treated plots after application. Reduction percentages were varied due to the start time of application, number of sprays/plot and interval periods between sprays, whereas the highest average reduction percentage of 81.33% was deduced for the plots received three sprays (as average of initial and residual effect of the third spray) started just after cotton plants emergence with one week interval. Also, at the end season program the Dursban reduced the numbers of aphids more than garlic extract indicating 89.67% reduction in plots received two sprays with one week interval. The lowest average of reduction percentage of 44.64% was deduced as average of initial and residual effect for the first spray which started at the tenth day after cotton plants emergence (in plots that received three sprays with three weeks interval sprays), the lowest average of reduction percentage of 78.00% was recorded for plots that treated by Dursban three times in plots planned to receive three sprays with three weeks interval. For more details of results, In case of the first program where the sprays started just after cotton plants emergence, the average of reduction percentage of garlic extract ranged 59.02-81.33% reduction. For the second program where the sprays started at 10 days after cotton plants emergence, the average of reduction percentage of garlic extract ranged 44.64-76.93%. In regard to the third program where the sprays started at 20 days after cotton plants emergence, the average of reduction percentage of garlic extract ranged 52.14-81.18%. The results of end season program showed that the average of reduction percentage ranged 60.05-76.03 % reduction of garlic extract in comparable with reduction percentages ranged 78.00-89.67% for Dursban.

Generally, the Dursban gave relatively high aphids control at the end season program and garlic extract also especially at early season programs. In regard to garlic extract efficacy, the first program tended to be the highest sustainable control of aphids on cotton plants, where the sprays started just after cotton plants emergence, whereas the numbers of aphids were very low and the plots received three sprays at different interval periods (one, two and three weeks intervals). The results of statistical analysis revealed that, there were highly significant differences between the reduction percentage averages of different programs ($P < 0.01$, $LSD_{0.05}= 1.56$), sprays numbers ($P < 0.01$, $LSD_{0.05}=1.35$) and interactions between factors, while it was insignificant for interval periods.

Cotton whitefly, *Bemisia tabaci* Genn.

Data on mean percent values of whitefly populations as affected by the different treatments of the garlic extract compound as tabulated in Table 2 showed that garlic extract recorded best efficacy in reducing the populations of whitefly by the highest mean percentage of 78.89%, recorded for the plots received two sprays with one week interval started just after cotton plants emergence. On the other hand, the lowest reduction level of 29.78% of whitefly numbers recorded in the plots of the first spray at the end season program (in plots that received three sprays with three weeks interval). In the same trend the first program where the spray started just after cotton plants emergence tend to be the best sustainable whitefly control program recording reduction percentages ranged 43.70-78.89%, while the lowest effective program of garlic extract was of end season one ranged 29.78 - 77.33% reduction, where Dursban compound recorded relatively high reduction ranged 65.33 -79.00% at the end season program.

Table 1. Reduction percentages in aphid numbers on cotton plants sprayed with garlic extract (Nat-108) as experimental program during 2014 cotton growing season

Program	Treatments	One week			Average	Two weeks			Average	Three weeks			Average
		1st spray	2nd spray	3rd spray		1st spray	2nd spray	3rd spray		1st spray	2nd spray	3rd spray	
Just emergence	Nat-108	59.02	74.80	81.33	71.72	68.86	75.62	79.00	74.49	66.92	72.91	72.91	70.91
10 days after emergence	Nat-108	51.22	66.96	70.05	62.74	51.20	67.43	67.37	62.00	44.64	76.93	70.65	64.07
20 days after emergence	Nat-108	52.14	77.22	77.39	68.92	59.98	81.18	76.99	72.72	63.72	77.87	62.75	68.11
End season	Nat-108	60.18	76.03	70.16	68.79	60.05	75.13	64.64	66.61	63.14	72.92	64.66	66.91
	Dursban	85.33	89.67	86.00	87.00	80.33	83.67	84.33	82.78	79.67	80.00	78.00	79.22

$LSD_{0.05}$ values for programs= 1.56, for spray interval periods and sprays number= 1.35.

Table 2. Reduction percentages in whitefly numbers on cotton plants sprayed with garlic extract (Nat-108) as experimental program during 2014 cotton growing season

Program	Treatments	One week			Average	Two weeks			Average	Three weeks			Average
		1st spray	2nd spray	3rd spray		1st spray	2nd spray	3rd spray		1st spray	2nd spray	3rd spray	
Just emergence	Nat-108	54.21	78.89	71.82	68.31	43.70	56.29	70.49	56.83	59.64	57.94	56.14	57.91
10 days after emergence	Nat-108	62.99	56.29	61.87	60.38	40.41	46.98	56.62	48.00	46.39	53.22	63.65	54.42
20 days after emergence	Nat-108	66.99	33.33	47.28	39.20	44.19	65.89	57.37	55.82	58.44	58.85	62.21	59.83
End season	Nat-108	40.96	49.76	77.33	56.02	29.78	44.33	51.80	41.97	31.11	41.75	31.89	34.92
	Dursban	78.33	76.67	79.00	78.00	69.00	70.67	71.00	70.22	65.33	68.67	67.00	67.00

$LSD_{0.05}$ values for programs= 4.69, for spray interval periods and sprays number= 4.06.

Table 3. Reduction percentages in leafhopper numbers on cotton plants sprayed with garlic extract (Nat-108) as experimental program during 2014 cotton growing season

Program	Treatments	One week				Two weeks				Three weeks			
		1st spray	2nd spray	3rd spray	Average	1st spray	2nd spray	3rd spray	Average	1st spray	2nd spray	3rd spray	Average
Just emergence	Nat-108	57.83	75.45	73.03	68.77	65.29	69.53	77.11	70.64	62.43	58.48	53.87	58.26
10 days after emergence	Nat-108	59.14	66.91	62.75	62.93	64.89	76.75	71.99	71.21	59.23	73.33	68.55	67.04
20 days after emergence	Nat-108	49.96	82.51	25.59	52.69	73.71	63.16	55.95	64.27	62.73	66.38	57.89	62.33
End season	Nat-108	55.82	73.64	59.58	63.01	47.43	19.02	41.99	36.15	49.61	67.29	67.15	61.35
	Dursban	75.33	78.00	77.00	76.78	74.00	76.67	77.00	75.89	69.67	72.33	74.00	72.00

$LSD_{0.05}$ values for programs= 3.44, for spray interval periods and sprays number= 2.99.

Table 4. Reduction percentages in thrips numbers on cotton plants sprayed with garlic extract (Nat-108) as experimental program during 2014 cotton growing season

Program	Treatments	One week				Two weeks				Three weeks			
		1st spray	2nd spray	3rd spray	Average	1st spray	2nd spray	3rd spray	Average	1st spray	2nd spray	3rd spray	Average
Just emergence	Nat-108	77.76	84.12	83.09	81.66	75.80	76.14	71.42	74.45	64.84	58.91	49.27	57.67
10 days after emergence	Nat-108	39.19	62.47	60.19	53.95	52.35	68.47	62.42	61.08	55.09	60.69	50.40	55.39
20 days after emergence	Nat-108	45.02	55.56	64.72	55.10	51.74	68.11	21.19	47.01	43.44	52.81	57.89	51.38
	Dursban	90.00	93.83	95.27	93.03	88.00	89.43	87.69	88.37	83.37	85.47	84.77	84.54
End season	Found in very low numbers												

$LSD_{0.05}$ values for programs= 3.51, for spray interval periods and sprays number= 3.51.

Table 5. Reduction percentages in spider mite numbers on cotton plants sprayed with garlic extract (Nat-108) as experimental program during 2014 cotton growing season

Program	Treatments	One week				Two weeks				Three weeks			
		1st spray	2nd spray	3rd spray	Average	1st spray	2nd spray	3rd spray	Average	1st spray	2nd spray	3rd spray	Average
Just emergence	Nat-108	42.66	52.54	51.29	48.83	40.79	54.06	67.56	54.14	31.38	29.67	5.91	22.32
10 days after emergence	Nat-108	43.25	54.30	55.08	50.88	48.73	64.15	60.79	57.89	45.71	62.71	54.93	54.45
20 days after emergence	Nat-108	35.48	58.62	52.83	48.98	45.28	49.77	53.42	49.49	36.41	55.85	49.99	47.42
End season	Nat-108	38.34	60.87	57.37	52.19	39.32	40.59	37.75	39.22	45.68	57.84	53.95	52.49
	Dursban	65.45	67.54	65.55	66.18	59.88	63.56	65.00	62.81	56.99	57.55	58.64	57.73

$LSD_{0.05}$ values for programs= 2.87, for spray interval periods and sprays number=2.48.

Table 6. Reduction percentages in green bug numbers on cotton plants sprayed with garlic extract (Nat-108) at end season during 2014 cotton growing season

Used compound	One week				Two weeks				Three weeks			
	1st spray	2nd spray	3rd spray	Average	1st spray	2nd spray	3rd spray	Average	1st spray	2nd spray	3rd spray	Average
Nat-108	37.89	54.46	52.63	48.33	31.34	44.68	49.83	41.95	43.79	48.70	53.13	48.54
Dursban	87.00	89.76	90.55	89.10	84.65	86.43	87.00	86.03	78.53	80.00	81.87	80.13

$LSD_{0.05}$ values for spray interval periods= 1.05 and sprays number = 1.05.

Generally, it could be concluded that the garlic extract can be used as a good control agent against whitefly when sprayed at low population of pest early in the season, while Dursban can gave relatively good control at end season period.

Statistical analysis results cleared that, highly significant differences were recorded between the reduction percentage averages of different applied programs ($P<0.01$, $LSD_{0.05}= 4.69$), sprays numbers ($P<0.01$, $LSD_{0.05} = 4.06$)as well as interactions between factors, while it was only significant differences ($P<0.01$, $LSD_{0.05} = 4.06$) between spray interval periods.

Leafhoppers, *Empoasca* spp.

The garlic extract results in Table 3 cleared the efficacy of tested material against leafhoppers, *Empoasca* spp., as it caused reduction in the population of leafhoppers reaching to 82.51% recorded in plots at the second spray within the third program where the spray started at 20 days after cotton plants emergence (the interval period was one week). The best control level of leafhoppers, *Empoasca* spp. as reduction percentages ranged 25.59-73.03% were noticed in the treated plots sprayed three sprays with one week interval in all tested programs. On the other hand, the lowest efficacy

was recorded for plots treated at the end of season regardless to the number of sprays or interval periods between sprays, ranged 19.02-73.64% reduction in leafhoppers, *Empoasca* spp. population compared with reduction (%) of 69.67-78.00% in the numbers in plots treated by Dursban.

Generally the efficacy of garlic extract has shown remarkable insecticidal properties against the leafhoppers, *Empoasca* spp. for protecting cotton crop especially at early season period, while Dursban compound tended to be more effective at the end season period. The results of statistical analysis cleared that, highly significant differences were recorded between the reduction percentage averages of different applied programs ($P < 0.01$, $LSD_{0.05} = 3.44$), sprays numbers ($P < 0.01$, $LSD_{0.05} = 2.99$) and interactions between factors, while it was insignificant between spray interval periods.

Cotton thrips, *Thrips tabaci* Lind.

The garlic extract was applied against thrips insects only during the early season period, so the organophosphorous compound was not used against this pest. Results in Table 4 indicate that the bio-pesticides remained effective to combat the thrips on cotton plants throughout the observation period to reach three weeks after spray. In case of plots sprayed two times with garlic extract with one week interval in the 1st program, the thrips infestation showed the highest effect of 84.12% reduction. The first program tended to be the highest sustainable control showed 49.27-84.12% reduction in thrips insects population on cotton plants, where the sprays started just after cotton plants emergence, the numbers were very low and the plots received three sprays at different interval periods (one, two and three weeks intervals). The results of the other programs where the spraying started at 10 and 20 days after cotton plants emergence found in one category of reduction percentages ranged 39.19-68.47% and 21.19- 68.11% reduction for the two programs, respectively; compared with reduction percentages of Dursban sprayed in the 3rd program ranged 83.37-95.27% reduction.

Generally, three programs only using garlic extract were tested to control *T. tabaci*, where the end season program not applied in according to the very low numbers of thrips at end season period. The analysis of variance of the results indicated that, highly significant differences were recorded between the reduction percentage averages of different applied programs ($P < 0.01$, $LSD_{0.05} = 3.51$), sprays numbers ($P < 0.01$, $LSD_{0.05} = 3.51$), spray interval periods ($P < 0.01$, $LSD_{0.05} = 3.51$) as well as for interactions between all tested factors.

Spider mite, *Tetranychus* spp.

Results in Table 5 show that garlic extract as a botanical pesticide showed moderate effect against the spider mite, *Tetranychus* spp. and kept the target pest in relatively level under control throughout the period of experiment. The spider mite population on cotton plants sprayed with garlic extract exhibited the relatively high effect of 67.56% reduction in plots of the third spray (with two weeks interval sprays) under first program where the spraying operation started just after cotton plants emergence. In contrast to previous results, the lowest spider mite reduction percentage of 5.91% was deduced for the third spray in plots received three sprays (with three weeks interval sprays) under the first program where spraying operation started just after cotton plants emergence too. The second program where the spraying operation started 10 days after cotton plants emergence, tended to be the relatively good program to use garlic extract as a botanical pesticide against the spider mite on cotton plants as reduction percentages ranged 43.25-64.15% reduction. At the end season program where the efficacy of garlic extract compared with Dursban compound, the results cleared no remarkable variation found between the two tested materials, where the garlic extract ranged 37.75-60.87% and Dursban ranged 56.99-67.54% reduction in mite population regardless to sprays numbers or interval periods.

The analysis of variance indicated that the effect of tested bio-pesticide against the spider mite affected the infestation on cotton plants highly significant as programs variance ($P<0.01$, $LSD_{0.05} = 2.87$), as spray interval periods variance ($P<0.01$, $LSD_{0.05} = 2.48$), as sprays numbers variance ($P<0.01$, $LSD_{0.05} = 2.48$) and

as interaction, highly significant variances were found except that of programs sprays numbers.

Green stink bug, *Nezara viridula* L.

The obtained results (Table 6) showed that only the end season program was applied to evaluate the efficacy of garlic extract as a botanical pesticide in comparable with Dursban compound against green stink bugs, where the spraying started at early-August. The garlic extract appeared low-moderate efficacy to bugs with relatively high reduction percentage of 54.46% recorded for plots received two sprays with one week interval, while the lowest percentage of 31.34% was recorded for plots received one spray with two weeks interval, while the Dursban compound gave good control to this pest as reduction percentages ranged 78.53-90.55% in the population of green stink bugs.

Generally, it could be decided that, Dursban can be used as effective insecticide against *N. viridula* at the end season period. The results of two ways ANOVA statistical analysis cleared that, highly significant differences were recorded between the reduction percentage averages of sprays numbers ($P < 0.01$, $LSD_{0.05}$= 1.05), spray interval periods ($P < 0.01$, $LSD_{0.05}$ = 1.05) and interaction between the two tested factors.

Pink bollworm, *Pectinophora gossypiella* (Saund.)

The obtained results in Table 7 show that the effect of garlic extract as a botanical pesticide on the population of pink bollworm was low to moderate in relative to its effect on piercing-sucking pests and in comparing with Dursban compound, where the results of tested spraying programs which started when the infestation percentage of bolls by pink bollworm reached to 2% and varied as interval periods between sprays (one, two and three weeks interval) indicated that the relatively high reduction percentage was 61.50% recorded for plots treated with two sprays at one week interval compared with 96.99% for the Dursban compound in the same program. The relatively low effect of garlic extract on pink bollworm of 25.0% recorded at the 5th week after application for plots received three sprays with two weeks interval compared with 84.30% for the organophosphorous compound recorded at the 7th week after application for plots received three sprays with three weeks interval.

Generally the all tested programs reduced the infested boll numbers in comparison with control but the conventional insecticide was more effective than the botanical pesticide, garlic extract Nat-108.

Cotton leafworm, *Spodoptera littoralis* (Boisd.)

Results in Table 8 cleare that the garlic extract as a botanical pesticide recorded low effect on the population of cotton leaf worm, *S. littoralis* where the reduction percentages of garlic extract ranged 23.30-25.80% reduction compared with 70.56-90.00% reduction for Dursban compound in the pest population throughout the experimental period of 9 days. So, the garlic extract cannot considered as a botanical pesticide against cotton leafworm under cotton field conditions at Sharkia Governorate but needs more studies to evaluate its efficacy on different levels of cotton leafworm infestation and stags.

The Side Effects on Total Predators Associated with Cotton Pests

Furthermore experiment was conducted also to evaluate the side effects of garlic extract as a botanical pesticide on the population of predators in cotton fields at early, end season periods compared with Dursban compound at end season period. Results in Table 9 show that the garlic extract as a botanical pesticide tested to control piercing-sucking pests and each of pink bollworm and cotton leafworm found influencing predators population by different sprays among the tested application programs but in relatively low reduction percentages. The relatively high negative effect of garlic extract against predators presented as 65.65% reduction at the first program and 62.91% at end season program. In general vision, the tested material was tended to be safe to predators especially throughout its effective activity period during the period from seedling to the end of growing season of cotton plants that confirmed by the results of the third program wherein the reduction ranged between 2.57-21.46% reduction percentages

Table 7. Reduction percentages of pink bollworm treated with garlic extract in cotton fields during season 2014

Program	Used material	Indicated weeks after application						
		1	2	3	4	5	6	7
One week interval	Nat-108	33.3	61.50	60.90	55.90	47.70	36.80	26.90
	Dursban	92.43	94.33	96.99	95.88	91.6	90.00	87.65
Two weeks interval	Nat-108	33.30	38.05	47.80	38.20	25.00	31.60	31.70
	Dursban	87.35	92.00	91.89	90.00	85.76	87.65	85.33
Three weeks interval	Nat-108	33.30	38.50	34.80	35.30	31.80	35.10	28.60
	Dursban	84.55	87.63	88.00	85.87	86.78	85.00	84.30

Table 8. Reduction percentages of cotton leaf worm treated with garlic extract and Dursban in cotton fields during, season 2014

Treatment	Indicated days after application			
	3	5	7	9
Nat-108	**24.60**	**25.80**	**24.40**	**23.30**
Dursban	**90.00**	**80.87**	**78.50**	**70.56**

Table 9. Reduction percentages in predators numbers on cotton plants sprayed with garlic extract (Nat-108) as experimental program during 2014 cotton growing season

Program	Treatments	One week			Average	Two weeks			Average	Three weeks			Average
		1st spray	2nd spray	3rd spray		1st spray	2nd spray	3rd spray		1st spray	2nd spray	3rd spray	
Just emergence	Nat-108	37.47	58.08	65.65	53.73	33.43	42.87	39.15	38.48	40.56	33.04	42.12	38.57
10 days after emergence	Nat-108	25.71	30.15	17.82	24.56	29.38	31.68	29.07	30.04	32.59	25. 29	15.24	24.37
20 days after emergence	Nat-108	12.64	11.96	12.75	12.45	9.22	9.94	8.81	9.32	2.57	11.74	21.46	11.92
End season	Nat-108	56.45	62.91	61.73	60.36	57.09	52.98	56.99	55.69	61.39	56.46	56.72	58.19
	Dursban	95.65	97.00	99.76	97.47	92.54	94.00	96.32	94.29	87.44	89.00	94.00	90.15

$LSD_{0.05}$ values for programs= 2.17, for spray interval periods and sprays number= 1.88.

in predators population. On the other hand, the Dursban compound caused serious damage to the population of predators associated with treated cotton plants, where it reduced its number by 87.44-99.76% throughout the experimental period at the end season program.

The results of statistical analysis cleared that, highly significant differences were recorded between the reduction percentage averages of different applied programs ($P<0.01$, $LSD_{0.05}$= 2.17), significant in case of sprays numbers ($P<0.05$, $LSD_{0.05}$=1.88), spray interval periods ($P<0.05$, $LSD_{0.05}$=1.88) and interactions between tested factors.

Obtained results were in agreement with the findings of Mason and Linz (1997) who found that garlic extract had repellency effect on European starlings (*Sturnus vulgaris*). Nauen *et al.* (1998) and Dheenadayalan (1999) who reported that application of aqueous extract of garlic and other botanicals has reduced aphid population by 40 to 70%. Zhou and Liang (2003) also reported repelling and controlling effect on *A. gossypii* by using alcoholic extract of garlic and other plant species. Zhou *et al.* (2004) who found that volatile oils had highly effect on *A. gossypii*. Prowse *et al.* (2006) indicated that the food-grade garlic juice concentrate caused significant mortality in eggs and adults of two target species of dipterous insects. The reduction in hatch rate of the eggs may be due to contact with the garlic juice solution directly or through exposure to vapors from the juice. Bahar *et al.* (2007) found that the garlic extract showed similar performance to that of mean as toxic and repellency against bean aphids on yard-long bean and did not affect the most common and recognized predators in the laboratory. Bardin *et al*. (2008) examined the effect of bio-pesticides and their efficacy to control insect pests of tomato and found that the bio-pesticides appear to be a promising biological control agent against whiteflies. Dancewicz and Gabryś (2008) assumed that garlic water extracts have an advantageous effect on the potato plants in protecting them against peach aphid. Noonari (2008) examined the effect of bio-pesticides (garlic source) against jassid on brinjal. Ahmed *et al.* (2009) conducted field experiment to determine the effect of garlic extract and other plant extracts against the insect pests of cowpea. All the plant extract treatments were significantly better than control treatments. Arain (2009) found that the garlic extract was least effective against mealy bug with mortality of 75.82% after 72 hours treatment. Bagavan *et al*. (2009) also observed that volatile oils had distinct repelling effect on *A. gossypii*. Bushra (2015) found that tobacco has more potential of toxicity against ladybird beetle as compared to other plant extracts *i.e.* neem, dhatura and onion. The tobacco extract showed highest toxicity against syrphid fly followed by neem while dhatura and onion showed the same effect.

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تأثير مستخلص الثوم بالمقارنة بمبيد الكلوروبيريفوس ضد الآفات الحشرية والمفترسات المصاحبة لها في حقول القطن في محافظة الشرقية- مصر

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أُجريت التجارب في حقول القطن المزروعة بصنف جيزة ٨٦ في الزقازيق – محافظة الشرقية موسم ٢٠١٤، وتم تطبيق أربعة برامج بثلاث رشات لكل منها بأحد مستحضرات مستخلص الثوم التجارية نات- ١٠٨ واختلفت البرامج باختلاف توقيت بداية أول رشة والفترات البينية للرشات وذلك لتطوير التوجه للتكنولوجيا الصديقة للبيئة لمكافحة حشرات المن والذبابة البيضاء والتربس والأكاروس ونطاطات الأوراق والبقة الخضراء ودودة لوز القطن القرنفلية ودودة ورق القطن بالإضافة إلى تحديد الآثار الجانبية على المفترسات الموجودة في حقول القطن والمصاحبة للآفات المختبرة مثال خنافس أبي العيد وأسد المن والرواغة وبقة الأوريس وثنائيات الأجنحة والعناكب الحقيقية، وأوضحت النتائج المتحصل عليها أن المستخلص التجارى للثوم عند استخدامه بمعدل واحد لتر/١٠٠ لتر ماء أعطى كفاءة عالية نسبيا ضد حشرات المن ونطاطات الأوراق والتربس بنسبة خفض وصلت إلى٨١,٣٣ ، ٨٢,٥١ و٨٤,١٢% على التوالي كما أعطى كفاءة متوسطة ضد دودة اللوز القرنفلية والذبابة البيضاء والأكاروس والبقة الخضراء بنسبة خفض وصلت إلى ٦١,٥٠ ، ٧٨,٨٩ ، ٦٧,٥٦ و ٥٤,٤٦% على التوالي، كما أوضحت النتائج أن تأثير مستخلص الثوم كان منخفضا ضد المفترسات المصاحبة باستثناء نهاية الموسم حيث كان أعلى تأثير نسبى ٦٢,٩١%، بينما سجل أقل كفاءة ضد دودة ورق القطن مسببا نسب خفض تراوحت بين ٢٣,٣٠ – ٢٥,٨٠% بالمقارنة مع ٧٠,٥٦– ٩٠,٠٠% في تعداد دودة ورق القطن المعرضة لمبيد الدورسبان (كلوروبيريفوس) لذلك لا يمكن اعتبار مستخلص الثوم مبيد نباتي ضد دودة ورق القطن تحت ظروف حقول القطن في محافظة الشرقية ولكن يحتاج لمزيد من الدراسات حول استخدامه علي مستويات مختلفة من الإصابة وأطوار هذه الآفة، بالنظر إلى النتائج المتحصل عليها لاختبار كفاءة مستخلص الثوم نجدها توضح أن البرنامج الأول (بداية الرش عقب الإنبات مباشرة) كان أفضل البرامج لاستخدام مستخلص الثوم في مكافحة كل من حشرات المن والذبابة البيضاء والتربس على نباتات القطن حيث كان تعداد الآفات منخفضا بينما كان البرنامج الثالث (بداية الرش بعد ٢٠ يوم من الإنبات) هو الأفضل لمكافحة نطاطات الأوراق ، أما في حالة البقة الخضراء وجد أن مركب الدورسبان هو الأفضل كفاءة ضدها في نهاية الموسم، في النهاية نخلص إلى أن مستخلص الثوم يمكن اعتباره آمناً بالنسبة للمفترسات خلال فترة البادرات وبداية موسم نمو نباتات القطن حيث تراوحت نسب التأثير ما بين ٢,٥٧ -٢١,٤٦ % خفضا في تعداد هذه المفترسات لذلك يمكن التوصية باستخدام مستخلص الثوم بكفاءة ضد حشرات من القطن ونطاطات الأوراق وتربس القطن ودودة اللوز القرنفلية في برنامج المكافحة المتكاملة للآفات في حقول القطن، كما أوضحت النتائج أن المركب الفوسفوري العضوي دورسبان يُمكن اعتباره مبيد جيد لمكافحة آفات القطن حيث سجل نسب خفض تراوحت بين ٥٦,٩٩-٩٦,٩٩% بينما سبب ضرراً بالغاً للمفترسات المصاحبة على نباتات القطن خلال فترة نهاية الموسم حيث وصلت نسبة الخفض إلى ٩٩,٧٦% في تعداد المفترسات مما يحدث خلل في التوازن الطبيعي في بيئة زراعة القطن.

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