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Applied two formulations for controlling *Tetranychus urticae* koch on the cultivation of sesame intercropping with cotton in the field

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Abstract
The cotton, *Gossypium barbadense* L. known as white-gold and most one important economically and industrial crop in "Egypt" long ago and worldwide. *Tetranychus urticae* (two-spotted spider-mite) is the most important agricultural pests worldwide. Here we investigated the efficacy of acaricides, Cotton is notorious for being susceptible to many diseases. Bt cotton and sesame are mainly affected by sucking pests after a decrease in the intensity of pesticides. The polyphagous-pest Two-spotted, spider-mite, "*Tetranychus utricae* Koch." infects range-wide crops. The pest "*Tetranychus urticae* Koch." caused large losses in yields in most of agricultural-crops like, cottons, horticulture, ornamentals and vegetables-crops. In this study, the experiments were conducted in 2019-2020 seasons, in Sakha-Agricultural-Research- Station at Kafr El-Sheikh Gov. "310-07¯ N-Latitude & 300-57¯ E-longitude" with about 6 mean-elevation on sea-level "MSL" - Egypt, to studying tested compounds effect "Chlorfenapyr, Neem, jojoba extract and intercropping-yields, some yield attributes and pests population of cotton and sesame. Cotton (Gossypium barbadense L.) and sesame (Sesamum indicum) were sole cropped and intercropped, chlorfenapyr Nano was most-effective on density reduction of stages-motile populations of mite "*T. urticae"* followed by "chlorfenapyr common" while "neem extract Nano" was moderately-effect while, jojoba extract Nano appears lowest- effective compounds on density reduction of stages-motile populations of spider mite "*T. urticae".* A one-week after-application showed decreasing in density of motile- stages populations of "*T. urticae"*. Generally, all-treatments were most-effective in population-density-reduction, based-on of this reduction; the all-compounds showed more-effective on density reduction of mite "*T. urticae"* population on cotton and sesame.The land equivalent ration (LER) and mean net incomes were taken the descending order: chlorfenapyr Nano > neem extract Nano > jojoba extract Nano effected on Sesame with Cotton in the two studied seasons.

Keywords: cotton, sesame, intercropping, chlorfenapyr, nano, neem, jojoba, land equivalent ratio

Introduction
The cottons "*Gossypium barbadense L.*" is a economically major-important crops and occupied a place as national economic income in Egypt, Mesbah *et al.,* 2004 [15], and considerable more than ½ incomes of 2-millions farmers small-scale. Many insect species attack cottons, early in all growing stages Salama *et. al.*, 2006 [18]. The cotton sucking pest complex of cotton includes aphid, highest share damages to crop of cotton done by white-fly, jassid, red-cotton-bug, thrips, mealy-bug and dusky-cotton- bug.
The essential-oils of plants are new way for controlling many pests especially sucking pests because their toxic-effects by ingestion action; contact action and fumigation action, in addition to, it have a highly-significant as a repellent agents and behavioral-effect. The current work were conducted to study of some pesticides effects; challenger, oberon, lambda, lant, neem-oil and eucalyptus-oil to control "adult-females" and "eggs-stages" of spider mite "*T. urticae"* on cotton plants and semsem plants. The natural-extracts of plants considerable a newly-tools to control like phytophagous-mites specially, T urticae, which caused most economic-losses in agricultures. (Akhtar *et al*., 2010) [4].
The sesame "*Sesame indium*" one of major-crop "oil-seed" all over world and there are fifteen health and nutrition benefits of sesame seeds (*15 Health and Nutrition Benefits of Sesame Seeds (healthline.com*). Abou-Kerisha *et al.,* (2008) [2] recorded decreasing of all sesame-varieties-yield in intercropping-conditions. Sesame-variety "Giza-32" was surpass other varieties "Shandaweel 3" and "Toshka 1" in plant-height, branches-no./plant, capsules-no./plant, seed-yield/plant and seed- yield/fed., and highly plant-density 100% led to highly sesame-seed-yield/fed. In 1st- season results showed increasing (46.93 and 13.50%), in 2nd results were (2.46 and 8.71%) and in combined-data over low and medium-density treatments recorded (25.86 and 11.19%) respectively. Abdel-Galil and Abdel-Ghany (2014), indicated that, the intercropping pattern3 groundnut:1 the sesame were higher-groundnut-yield attributes than pattern2:2, while highest-sesame-yield attributes were obtained by pattern2:2. Agricultural experts suggest that a way to improve productivity of cotton is intercropping

system. For these reasons, Intercropping Cotton and sesame was done in Egypt as a conventional practice from years ago. Use of intercropping by smallholders is common in the rain fed areas all over the world Ofuso-Amin and Limbani, 2007 [16]. Inter-cropping advantages compared with monocropping represented by soil-conservation, lodging-resistance, yield-increment Banik *et al.*, 2006 [6]. Cultivation of two-crops together may led to intra-specific competitions and facilitation inter-between plants Zhang and Li, 2003 [24]. Some indices like Land- Equivalent-Ratio "LER" Relative-Crowding-Coefficient, Competitive-Ratio, Actual- Yield-Loss and advantages of monetary were used in inter-cropping system for describe economic-aspects and competitions, Ghosh 2004 [9], Yilmaz *et al*., 2007 [23] and Shahid and Saeed 1997 [19], mentioned that, the dominant-effect of cottons were valued "A-positive" when grown in association with mung-bean, mash-bean and lin-seed. However, such indices have not been used for cotton and sesame to evaluate the competition among species in Egypt. Thus, the mains-objectives of current study to estimate effects of tested-compounds and inter-cropping of sesame "*Sesame indium*" and cotton "*Gossypium barbadense L."* on growth, yield, yield components and pests population of both plant species. Working on different inter-cropping patterns that
could maximize-resource-efficiency and increasing net-incomes and maximum use inputs for farmers.

Materials and Methods

The experiments were conducted in 2019-2020 seasons, in Sakha- Agricultural-Research-Station at Kafr El-Sheikh Gov. "310-07¯ N-Latitude & 300-57¯ E-longitude" with about 6 mean-elevation on sea-level "MSL" - Egypt, to studying tested compounds effect "Chlorfenapyr, Neem, jojoba extract and intercropping- yields during summer season 2019 and 2020, on spider-mite *"Tetranychus urticae",* attacking sesame and cotton-plant were designed as a plot-laid-out by complete- randomize-block design and the each treatment were replicates four-times. The cottons "c.v. Giza 94" and sesame "c.v. Shandaweel 3" were employed in this study seeds were received from Cotton-Crop Research Inst., and Oil-Crops Res. Dept.,
Field-Crops Research Institute, Agric. Research Center. During seasons 1st & 2nd, cotton was sown on 12th April and 14th April, respectively. Cottons "main crop" was grown at normal density on all ridges. Each of sub-plot area ranged 42m2 "wide 6m. × long 7m.", was containing five broadcasts. Cotton seed rates was 30 kg seed/fed was grown on two sides of all ridges (100%) at 25 cm between hills (2 pl/hill), while sesame seed rate was 2 kg seed/fed. was grown on broadcast (50%) one alternative another broadcast at 20 cm. between hills (1 pl /hill).Solid planting of cotton and sesame were sowing as recommended. Application of super-phosphate-fertilizer 30kg. P2O5/fed-1, added as calcium-super-phosphate form "15.5%P2O5" before sowing and preparation of soil. Nitrogen-fertilizer 60kg. N/fed-1, applied as a two-equal- doses "i.e., at 1st and 2nd irrigations". Potassium-fertilizer 24kg. K/fed-1, applied with 1st dose for Nitrogen-fertilizer. The irrigations for each season growing were added nine-times. Experiments were established on a clayey-soil well-drained.

Data recorded on two crops

At harvesting, five-guarded/plants chosen randomly for determine plant-averages of;

Cotton

1. Plant-height/cm.
2. 2- No. of fruiting-branches.
3. Boll-weight/gm.
4. 4- Seed-cotton yield/plant/gm.
5. Seed-yield/fed/kantar.
6. 6- Lint-cotton yield/plant.
7. Lint %.
8. 8- Fiber-length/mm.
9. Fiber-strength/gm./tex.
10. 10- Fiber-fineness/micromere value.

Sesame

1. Plant-height/cm.
2. No. of branches/plant.
3. No. of capsules/plant.
4. Seed-index/g.
5. Seed-yield/plant/g.
6. seed-yield/fed.

Ratio of area needed at sole-cropping to that of inter-cropping at same level- management to producing the equivalent-yield and calculated according to Mead and Willey, 1980 [14] as follows;

$$\mathbf{LER = (Yab/Yaa) + (Yba/Ybb)}$$

Where;
"Yaa and Ybb" are Sole-Crop-Yields of "crops a and b", respectively, while "Yab" is intercrop-yield of "crop a", and "Yba" is intercrop-yield of "crop b".

Economic evaluation
Each treatment was calculated of tested-seasons using market-prices average/Egyptian-pounds L.E., and average market-prices for cottons calculated 2150 L.E./kentar-1, and 2500 L.E./ardb-1 for sesame-yield.

Statistical analysis
Data was statically analyzed according to Gomez and Gomez (1984) [10]. Experimental-design was completely-randomized-blocks in four-replications.

Compounds tested
a- Tested compounds

Table 1

Tested compounds	Common name	Chemical name (IUPAC)	Source
Chlorfenapyr	Clorofenapyr	"4-bromo-2-(4-chlorophenyl)-1-ethoxymethyl-5-trifluoromethyl-1H-pyrrole-3-carbonitrile"	EL-Help Pesticides and Chemicals Company, Egypt

b- Plants extracts

Table 2

Plant extracts	Common name	Plant used	Source
Neem extract	Neem extract	extract	EL-Help Pesticides and Chemicals Company, Egypt
jojoba extract	jojoba extract	extract	

Preparation of plant extracts
The plant materials were air dried at room-temperature and room-ground by blender to obtain on fine-powder. 100gm. from cloves powdered were soaked in solvent system 300ml. "ethanol and acetone 1:1 v/v", the maceration of neem-extract and jojoba-extract were done for one week. During maceration period, neem extract and jojoba extract were shaked for "6 hrs" by use of electrical-shaker. Extract was filtered by sterilized-cotton and filter-paper (Wathman No: 101). Anhydrous- sodium-sulphate used in drying of extract and a rotary-evaporator used to dryness. Residues were weight dissolved in acetone and ethanol and kept at 4°C to make the desired concentration (Ismail, 2009) [12].

Characterization of commercial and prepared nanoparticles
In this thesis, Transmission Electron Microscope (TEM) used in characterizing the shape-controlled nanocrystals (Prabhu *et al*., 2013) [17]. The TEM was used for the characterization and the size determining of tested pesticide formulations and extracted NPs samples, compared to the commercials samples. Samples were prepared in an aqueous solution phase before running the TEM.

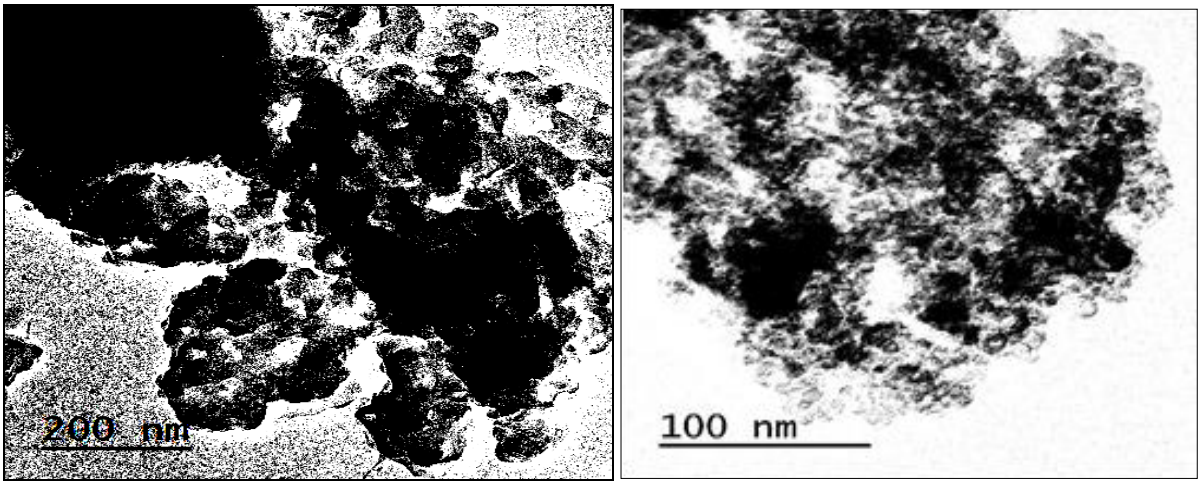

Fig 1: TEM images of chlorfenapyr (left) and synthesized processing (right).

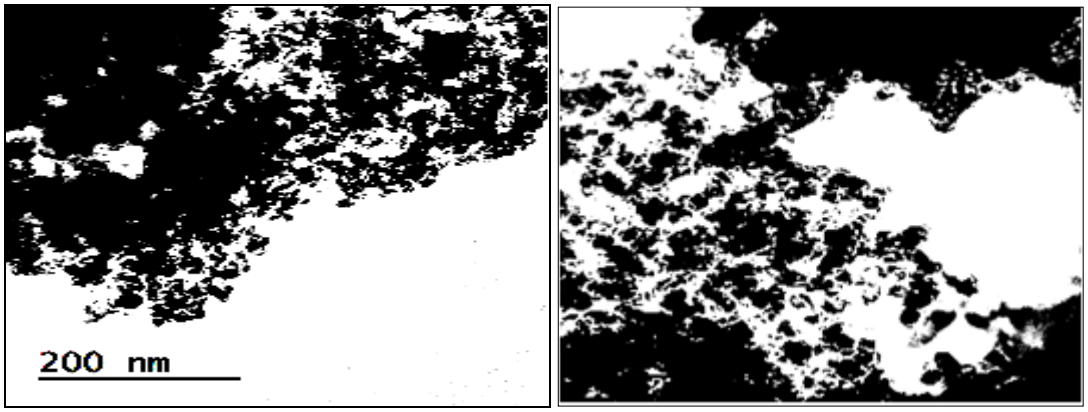

Fig 2: TEM images of neem extract commercial (left) and synthesized processing (right).

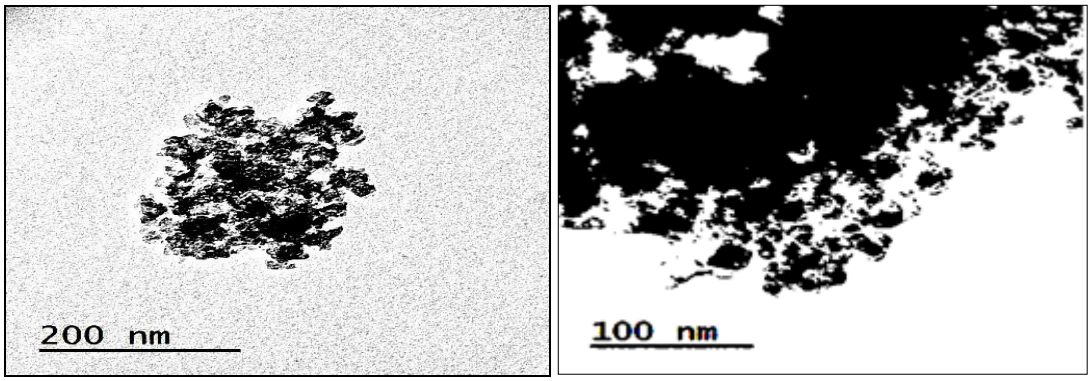

Fig 3: TEM images of jojoba extract commercial (left

Field experiments

One experiment was conducted in Sakha-Agricultural-Research-Station at Kafr El-Sheikh Gov., Egypt, to evaluation some tested-compounds effect on spider- mite *"Tetranychus urticae"* attacks cottons and semsem-plant were designed as a plot-laid-out by complete-randomize-block design. Each treatment was replicated four-times. The tasted-compounds were applied at their ½ rates of recommendation by use of knapsack-sprayer volume 20 L. with one-nozzle. Water-rate used for compounds diluting rates 200 Liter/Fad. 10-samples from "cottons and sesame- leaves" collected randomly before and after treatment from each plot with intervals of 2-days and 1-week later. Each treatment calculated for Infestation-reductions% by equation of "Henderson and Tilton 1955". Duncan's-multiple-range tests used to statically-comparing of different-means at level (5%).

Results and Discussions

Field studies

Field-experiments were carried out for studying relative-susceptibility by two applied formulations and their effects on motile-stages of spider-mites "*Tetranychus urticae"*. All The tasted-compounds were applied at their ½ rates of recommendation. 10-samples from "cottons and sesame-leaves" collected randomly before and after treatment from each plot with intervals of 2-days and 1-week later. Reduction% of infestations of each treatment recorded and estimated with equation of Handerson and Tilton 1955. Duncan's-multiple-range-test "Duncan, 1955" [7], used for analyzed for all data recorded.

Effect of the tested compounds on stages-motile of mite *T. urticae,* on cotton

The population density of stages motile of *T. urticae* were decreased after four weeks of cultivation. Data recorded in Tables 1 and 2, showed that, In the 1st season (2019), chlorfenapyr nano formulation was the most-effective on motile-stages reduction of *T. urticae,* recorded 71.76 %, followed by chlorfenapyr common formulation which recorded 62.81, while neem extract nano was moderately-effect with 52.69. Jojoba extract nano and jojoba extract common formulations appears lowest-effective compounds on of stages motile reduction of mite, *T. urticae,* recorded 40.87and 24.17% respectively. After application of one-week, observed that, decreasing in population density of stages-motile of spider mite, *T. urticae*. Generally, the most effective for all treatments on reduction of population density return to the direct effect on stages-motile of spider mite, *T. urticae.*

In 2nd season (2020), chlorfenapyr nano gave major effective on reduction of stages motile density of mite, *T. urticae,* recorded 68.84% followed-by chlorfenapyr common recoded 56.14%,while neem extract nano gave moderate- effects while. jojoba extract nano and jojoba extract common wear least-effective compounds with 28.66% and 18.02 % on population-density-reduction of motile- stages of tested pest. We note from the obtained results that there is a noticeable increase in the toxic effect of nano-compounds than in the known case, and that

is for the chemical compound and plant extracts, and the compounds in the known picture had low effects compared to nano-compounds and control on cotton plants.

Table 3: Effects of the experimented compounds on stages motile of spider-mite, *T. urticae*, on cottons in the field.

Compounds	Mites no. pretreatment	Mites no. posttreatment/weeks			
		1st -week	2nd -week	3rd -week	4th -week
Season 2019					
Chlorfenapyr nano	190.60	18.36	38.11	63.61	79.09
Chlorfenapyr common	195.22	33.60	58.19	78.40	85.23
Neem extract nano	188.37	55.45	78.38	85.09	95.72
Neem extract common	192.43	63.12	88.29	96.13	112.03
jojoba extract nano	189.13	78.61	89.72	102.43	124.12
jojoba extract common	203.16	116.58	123.30	148.71	156.18
Control to nano and common	232.40	212.32	208.18	202.18	198.15
Season 2020					
Chlorfenapyr nano	196.91	13.53	25.66	65.19	84.11
Chlorfenapyr common	189.32	40.76	58.71	72.72	94.29
Neem extract nano	193.18	53.40	66.38	83.69	103.32
Neem extract common	200.19	78.37	92.20	110.83	126.19
jojoba extract nano	202.01	90.92	108.12	128.62	138.80
jojoba extract common	205.12	120.37	138.27	142.13	164.72
Control to nano and common	248.33	220.16	204.32	198.38	187.55

Table 4: The reductions effects of experimented compounds on stages motile of spider-mite, *T. urticae*, on cottons in the field.

Compounds	% Reduction st th				General mean
	1-week	2nd–week	3 rd-week	4-week	
Season 2019					
Chlorfenapyr nano	89.50	84.66	61.95	51.45	71.76
Chlorfenapyr common	81.23	66.91	54.22	48.91	62.81
Neem extract nano	67.91	53.81	48.50	40.54	52.69
Neem extract common	64.24	49.07	43.05	31.88	47.06
jojoba extract nano	54.69	47.34	38.25	23.21	40.87
jojoba extract common	37.45	32.63	16.55	10.05	24.17
Season 2020					
Chlorfenapyr nano	92.36	81.33	58.42	43.35	68.84
Chlorfenapyr common	75.88	62.47	51.98	34.25	56.14
Neem extract nano	69.04	58.42	45.84	29.40	50.76
Neem extract common	56.15	44.27	30.79	16.79	37.00
jojoba extract nano	49.59	35.24	20.41	9.43	28.66
jojoba extract common	34.27	18.45	13.38	6.00	18.02

Effects of the experimented compounds on stages motile of spider- mite, *T. urticae,* on sesame in the field.
After application about one to four-weeks, showed, the population density of stages motile of *T. urticae*, were decreased. In the 1st season (2019), chlorfenapyr nano was most-effective on reduction of population of stages motile of spider-mite, *T. urticae*, recorded 61.18 %, followed with chlorfenapyr common recorded 54.36, while neem extract nano was moderately-effect with 48.12 while, jojoba extract nano and jojoba extract common appears lowest-effective compounds on population reduction of stages motile of spider-mite, *T. urticae*, recorded 21.67 and 18.57 % respectively. After application of one-week, observed that, decreasing in density of stages motile of *T. urticae*. Generally, the most effective for all treatments on reduction of population density based-on the effect on stages-motile of spider mite, *T.urticae.*
Data recorded in Tables 3 and 4, showed that, in 2nd season (2020) chlorfenapyr nano gave most-effective on reductions of population density of stages motile of spider-mite, *T. urticae*, recorded 60.81% followed-by chlorfenapyr common recoded 51.57 %,while gave moderate-effects neem extract nano while. Jojoba extract nano and jojoba extract common were least-effective compounds with 21.44% and 21.02 % on population-density-reduction of motile-stages of tested pest. It is clear from the results shown that the chemical compound has an effect both in the case of nano or in the known case, but the plant extracts had the least effect on the pest

under study, while the nano images showed noticeable effects than in the known case on the semsem crop of spider-mite *T. urticae*.

Table 5: Effects of the experimented compounds on stages motile of spider-mite, *T. urticae,* on semsame in the field.

Compounds	Mites no. pretreatment	Mites no. posttreatment/weeks			
		st 1 -week	nd 2 -week	rd 3 -week	th 4 -week
Season 2019					
Chlorfenapyr nano	198.55	16.44	43.52	83.12	83.67
Chlorfenapyr common	188.58	38.66	53.36	78.46	88.41
Neem extract nano	196.34	57.38	68.55	86.37	98.43
Neem extract common	193.23	79.57	95.75	108.53	115.62
jojoba extract nano	248.44	143.57	158.73	198.69	185.26
jojoba extract common	197.82	136.24	187.38	160.76	190.63
Control to nano and common	262.73	258.81	216.72	185.48	177.91
Season 2020					
Chlorfenapyr nano	197.35	15.57	43.74	75.62	86.57
Chlorfenapyr common	193.77	47.83	59.28	74.52	97.12
Neem extract nano	199.64	57.63	77.38	86.47	102.53
Neem extract common	209.22	87.63	96.63	108.53	119.65
jojoba extract nano	211.23	133.68	147.36	174.68	155.56
jojoba extract common	236.62	156.54	171.57	198.63	178.44
Control to nano and common	265.92	248.74	225.65	182.63	173.57

Table 6: Effects of the experimented compounds on stages motile reductions of spider- mite, *T. urticae,* on semsame in the field.

Compounds	% Reduction				General mean
	st 1 -week	nd 2 -week	rd 3 -week	th 4 -week	
Season 2019					
Chlorfenapyr nano	91.63	77.08	40.97	38.05	61.18
Chlorfenapyr common	79.29	65.76	41.33	31.08	54.36
Neem extract nano	70.48	57.75	37.97	26.30	48.12
Neem extract common	58.40	40.04	20.80	12.04	32.82
jojoba extract nano	41.63	22.69	12.76	9.61	21.67
jojoba extract common	30.44	14.61	14.58	14.65	18.57
Season 2020					
Chlorfenapyr nano	91.87	74.06	44.43	32.88	60.81
Chlorfenapyr common	74.57	64.20	44.23	23.31	51.57
Neem extract nano	70.26	54.65	37.19	21.14	45.81
Neem extract common	56.85	45.96	24.78	12.50	35.02
jojoba extract nano	34.81	18.37	19.91	12.67	21.44
jojoba extract common	31.85	15.16	21.71	15.38	21.02

Asmae *et al*. (2019) [5] evaluate the toxicity of essential oil chemical composition of Salvia officinalis and eucalyptus globulus, against the adults of two spotted spider mite, *T. urticae.* The results showed that the two oils showed increased mortality of spider mite on adults. *S. officinalis* and *E. globulushave* the potential to be developed as botanical acaricides for eco-friendly management of T. *urticae*. Wafaa and Heba, 2020 [21] evaluated the effect of neem essential oil and the aqueous neem extract against adult females of *Tetranychus urticae* under laboratory conditions. The results revealed that the active essential oil of neem was more effective than the aqueous neem extract. Wawdhane *et.al.* (2020) [22] evaluate the efficacy of different treatments plant extracts, Neem oil 2%, Neem seed extract 5%, *Tetranychus urticae* Tobacco leaf extract 10%, Metarhizium anisoplie 1x108 CFU/ml, Verticillium lecanii 1x108 CFU/ml and Beauveria bassiana 1x108 CFU/ml) against sucking pest whitefly of cotton. The result showed that Neem oil 2 per cent, Neem seed extract 5 per cent and Tobacco leaf extract 10 per cent were found effective towards reduction of sucking pests.

The efficiency of the tested compounds treatments on Cotton

Presented data in Table (5) illustrated that the effect of the efficiency of the tested compounds on Plant height, Number of fruiting branches, boll weight of cotton in the two growing seasons. All traits were no significantly affected by the tested compounds (nano, common) in the two seasons. the highly values were chlorfenapyr Nano

while, the lowest values jojoba extract common in two seasons. The results obtained are in conformity with the findings Wafaa and Heba, 2020 [21].

Table 7: Effect of the efficiency of the tested compounds on plant-height, fruiting-branches number, and boll-weight of cotton in 2019and 2020 seasons.

Tested compounds	Plant-height (cm)		No. of fruiting-branches		Boll-weight (g)	
Intercropping	1st-season	2nd-season	1st-season	2nd-season	1st-season	2nd-season
Cotton +sesame at Chlorfenapyr nano	180.5	180.8	7.97	8.23	2.58	2.63
Cotton +sesame at Chlorfenapyr common	176.7	177.3	7.53	7.70	2.38	2.40
Cotton +sesame at Neem extract nano	178.3	178.5	7.87	8.03	2.35	2.38
Cotton +sesame at Neem extract common	174.0	175.7	7.43	7.67	2.26	2.28
Cotton +sesame at jojoba extract nano	176.7	177.8	7.50	7.73	2.32	2.34
Cotton +sesame at jojoba extract common	173.3	174.9	7.27	7.13	2.17	2.19
L.S.D. 5%	1.435	1.724	0.232	0.336	0.343	0.177
F. Test	Ns.	Ns.	Ns.	Ns.	Ns.	Ns.
cotton sole cropping	186.54	188.22	7.92	8.11	2.95	3.02

Data obtained in (Table 6), showed the effect of the efficiency of the tested compounds on seed cotton yield/plant was not significantly and significant at the two seasons respectively, seed yield /fed, was significant at two seasons. Lint cotton- yield/plant and Lint % were not significant in two seasons. The obtained results were harmony with those reported by Asmae *et al.* (2019) [5] and Wawdhane *et. al.* (2020) [22]

Table 8: Effect Tested compounds for sesame with cotton on Seed cotton-yield /plant/g, Seed- yield/fed/kantar), Lint cotton-yield/plant and Lint% of cotton in 2019, 2020 seasons.

Tested compounds	Seed cotton-yield/plant/g		Seed yield /fed/kantar		Lint cotton-yield/plant		Lint %	
Intercropping	1st-season	2nd-season	1st-season	2nd-season	1st-season	2nd-season	1st-season	2nd-season
Cotton +sesame at Chlorfenapyr nano	196.1	196.3	11.36	11.47	79.4	79.4	41.02	40.90
Cotton +sesame at Chlorfenapyr common	194.0	194.2	10.48	10.56	79.1	79.1	40.86	40.75
Cotton +sesame at Neem extract nano	195.0	195.2	11.18	11.28	79.2	79.3	40.75	40.78
Cotton +sesame at Neem extract common	193.4	193.5	10.42	10.48	78.6	78.9	40.70	40.71
Cotton +sesame at jojoba extract nano	194.1	194.2	11.17	11.24	79.2	79.3	40.75	40.79
Cotton +sesame at jojoba extract common	192.0	193.0	10.48	10.53	79.0	79.1	40.43	40.50
L.S.D. 5%	1.290	1.098	0.428	0.415	0.684	0.534	0.349	0.063
F. Test	Ns.	*	*	*	Ns.	Ns.	Ns.	Ns.
cotton sole cropping	198.2	198.4	11.51	11.53	79.2	97.4	40.51	40.63

Table (7) showed the effect of the efficiency of the tested compounds on Fiber-length, fiber-strength/g/tex and fiber-fineness/micromaire/value, were not significant in all pervious traits at two seasons. The highest values in all traits at table (7), were found at the Chlorfenapyr nano compound at the two growing seasons. There results agreed with those reported by Ismail, 2009 [12] and Prabhu *et al.* 2013 [17].

Table 9: Effect of the tested compounds for sesame with cotton on fiber-strength/g/tex, fiber-fineness/micromaire/value, no. of fruiting-branches, and lint % of cotton in the two growing seasons.

Tested compounds	Fiber-length/mm		Fiber-strength/g/tex		Fiber fineness/micromaire/value/g	
Intercropping	1st-season	1st-season	1st-season	2nd-season	1st-season	2nd-season
Cotton +sesame at Chlorfenapyr	32.33	32.20	39.34	39.38	4.06	4.15

nano						
Cotton +sesame at Chlorfenapyr common	31.20	31.12	39.19	39.20	3.95	4.01
Cotton +sesame at Neem extract nano	32.12	32.1	39.33	39.37	4.01	4.12
Cotton +sesame at Neem extract common	31.35	30.52	39.12	39.15	3.93	3.98
Cotton +sesame at jojoba extract nano	32.14	32.12	39.32	39.36	3.98	4.10
Cotton +sesame at jojoba extract common	31.21	31.30	39.07	39.30	3.91	3.98
L.S.D. 5%	1.070	0.608	0.174	0.097	0.114	0.104
F. Test	Ns.	Ns.	Ns.	Ns.	Ns.	Ns.
Cotton sole cropping	34.36	34.48	39.34	39.37	4.22	4.35

Effect of the efficiency of the tested compounds treatments on sesame.

Data obtained in Table (8), showed that the effect of the efficiency of the tested compounds on plant-height, number of branches/plant and number of capsules/plant of sesame were not significant in all traits in the two growing seasons. The highest values in all traits at table (8) were found at the Chlorfenapyr nano compound at the two growing seasons. These results are in accordance with those obtained by (Ismail, 2009) [12].

Table 10: Effect of the tested compounds and density for sesame with cotton on plant-height, no. of branches/plant and no. of capsules/plant of sesame in the two growing seasons.

Tested compounds	**Plant-height/cm)**		**No. of branches/plant**		**No. of capsules/plant**	
Intercropping	**1st-season**	**1st-season**	**1st-season**	**2nd-season**	**1st-season**	**2nd-season**
Cotton +sesame at Chlo rfenap yr nano	114.1	114.53	2.29	2.35	108.53	108.65
Cotton +sesame at Chlo rfenap yr common	96.6	99.01	1.97	2.04	105.87	106.15
Cotton +sesame at Neem extract nano	113.5	114.34	2.26	2.33	108.13	108.35
Cotton +sesame at Neem extract common	97.6	99.01	1.90	1.90	106.48	106.67
Cotton +sesame at jojoba extract nano	112.4	113.39	2.25	2.31	108.01	108.07
Cotton +sesame at jojoba extract Common	97.7	97.75	1.85	1.91	105.32	105.54
L.S.D. 5%	3.108	3.401	0.150	0.093	1.662	1.830
F. Test	Ns.	Ns.	Ns.	Ns.	Ns.	Ns.
sesame sole cropping	116.21	116.36	2.32	2.44	109.48	109.56

Significant except seed yield /plant was significant at the two seasons growing. These results are in a great harmony with those reported by Wawdhane *et al.* (2020) [22].

Table 11: Effect of the tested compounds and density for sesame with cotton on seed-index/g, seed-yield/plant/g and seed-yield/fed of sesame in the two growing seasons.

Tested compounds	**Seed-index/g**		**Seed-yield/plant/g**		**Seed-yield/fed/ardab**	
Intercropping	**1st-season**	**1st-season**	**1st-season**	**2nd-season**	**1st-season**	**2nd-season**
Cotton +sesame at Chlorfenapyr nano	4.45	4.55	13.90	14.12	2.28	2.34
Cotton +sesame at Chlorfenapyr common	4.18	4.21	12.81	12.94	2.19	2.25
Cotton +sesame at Neem extract nano	4.43	4.54	13.72	13.83	2.26	2.33
Cotton +sesame at Neem extract common	3.93	4.01	12.56	12.67	2.13	2.22
Cotton +sesame at jojoba extract nano	4.42	4.51	13.09	13.23	2.13	2.22
Cotton +sesame at jojoba extract common	3.92	3.97	13.02	13.15	2.11	2.19
L.S.D. 5%	0.312	0.254	0.227	0.258	0242	0.250
F. Test	Ns.	Ns.	*	*	Ns.	Ns.
sesame sole cropping	4.63	4.75	15.22	15.34	5.00	5.40

Land-Equivalent-Ratio "LER" and Gross-Return L.E./fed-1

The land-equivalent-ratio is used method to calculation the effect of intercropping-systems and major used widely as measuring-index for intercropping- systems advantages on combined-yield of most crops. Also, it is defined as a relative- land-area in sole-crops required producing's yields achieve in inter-cropping. Obtained data in (Table 10), showed, that, values of land-equivalent-ratio were very affected with tested compounds efficiency on two-seasons growing. Around of tested compounds efficiency on land-equivalent-ratio, highest-values in two-seasons growing occurred with "Chlorfenapyr-nano" while, lowest-values recorded with "jojoba-extract-common". These results are in agreement with Toaima *et al.* 2004 [20], El-Sawy *et al*. 2006 [8] and AbouKhadra *et al.* 2013 [3], they reported that, "LER-values" showed highly with intercropping-systems. Affected of tested-compounds gross- return for tested-compounds, highest-values given with "Chlorfenapyr-nano" recorded (31240 and 28712 L.E./fed-1), at same-time, while lowest-values showed with tested-compounds "jojoba-extract-common, recorded (29078 and 26732) in the 1st and 2nd growing-seasons, respectively. Furthermore, the "Chlorfenapyr-nano" was effected on gross-return with over all tested-compounds for "sesame" in two- growing seasons. These results were in line with were reported by Ismail, 2009 [12], Mahdy and El-Said 2015 [13] and Wawdhane *et al.* 2020 [22].

Table 12: Effect of sowing date and density for sesame with cotton on the land-equivalent- ratio LER and gross-return L.E./fed-1 in the two-growing seasons.

Tested compounds	Land-equivalent-ratio		Gross-return L.E./fed-1	
1st-season		2nd-season	1st-season	2nd-season
Cotton +sesame at Chlo rfenap yr nano	1.41	140	31240	28712
Cotton +sesame at Chlo rfenap yr common	1.32	1.31	29360	26910
Cotton +sesame at Neem extract nano	1.41	1.39	31163	28618
Cotton +sesame at Neem extract common	1.32	1.30	31138	28564
Cotton +sesame at jojoba extract nano	1.41	1.39	29168	26814
Cotton +sesame at jojoba extract common	1.32	1.31	29078	26732
Sesame sole =12000, 14140/LE. Cotton sole=23.690, 20900/LE.				

Conclusion

This study aims to attach loading sesame on cotton with insect infestation of red spider *Tetranychus urticae*. Controlling the pest applied with two formulations (nano – common) of three compounds (Chlorfenapyr – Neem extract – Jojoba extract) at 2019 – 2020 seasons. The results showed that the pesticide chlorfenapyr had the most effective in controlling *T. urticae* with its two formulations (nano – common) in the two seasons of cultivation cotton and sesame plants, also had the highest quality for the two crops followed by neem extract and finally jojoba extract.

The previous study recommend more researches for developing a new methods to control *T. urticae* in a way that does not conflict with the surrounding environment. As well as conducting more research on the effect of plant extracts in control pest management as safe alternatives to reduce using pesticides.

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