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Effectiveness of auxins hormone and lanthanum oxide La2O3 on some physiological characteristics of *Aphis gossypii* infested squash plants

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Abstract
This study was carried out to evaluation the efficiency of two different materials (substances) on controlling the serious pest *Aphis gossypii* Glover (Aphididae: Hemiptera) infesting squash plants (*Cucurbita pepo* L.) through its effectiveness on the physiological characteristics of that insect. Examined substances were; the plant hormone auxins hormone (Indol acetic acid IAA) with two concentrations; 25 ppm and 50 ppm and the other substance was lanthanum oxide La2O3 also with two concentrations; 1 ppm and 5 ppm**.** Experiments were carried out at two different zones (governorates); Tokh zone (Qaliobya Governorate) and Perkash zone (Giza governorate) during seasons 2022 under greenhouses. Results obtained show that lanthanum oxide La2O3 was more effectiveness on controlling *A. gossypii* more than auxins hormone (Indol acetic acid IAA) at both of the two tested zones. This is appears in decreasing the mean population numbers of *A. gossypii* infesting squash plants when squash plants treatment by lanthanum oxide La2O3 more than when these plants treatment by auxins hormone IAA compared to control (squash plants did not treat with any substances). Results obtained indicated also that effectiveness of lanthanum oxide La2O3 was higher than auxins hormone IAA on the physiological characteristics of the tested pest *A. gossypii*. These physiological characteristics stimulated in the important internal substances secreted by that insect *A. gossypii*; two internal compounds (total proteins - total Lipids); two enzymes (lipase enzyme - kinase enzyme); two hormones (molting hormone - juvenile hormone) and two genes (alpha glucosidase gene - sucrase gene).
Statistical analyses show that were highly significant differences between the mean population numbers of the tested insect *A. gossypii* infesting squash plants treatment by both of the two tested substances IAA and La2O3 compared to control. And also there were highly significant differences between concentrations of the important internal substances secreted by *A. gossypii* which fed on squash plants treatment by both of IAA and La2O3 compared to control insects (insects fed on squash plants did not treat by any substance).

Keywords: Auxins hormone (IAA), lanthanum oxide La2O3, *Aphis gossypii***,** squash plants**,** physiological characteristics**,** greenhouses

Introduction
Squash plants (*Cucurbita pepo* L.) are one of the most famous and important vegetable crops all over the world. It planted in a wide range at both in the open fields and under greenhouses. Squash fruits are one of the most popular vegetables fruits in Egypt and it has a highly economic value and rich with many vitamins and menerals (Shehata *et al*., 2009) [16]. Also, squash planted in a wide range in different places in Egypt and its cultivated area increased gradually during recent years especially in the newly reclaimed areas, Abdein 2016 [1].
Squash plants infested with different insects such as *Aphis gossypii* Glover (Aphididae: Hemiptera) which consider one of the most serious pests infesting squash plants and many other vegetable crops Adriaan *et al*. (1994) [2] who add also that *A. gossypii* was seen as highly population on squash plants in both of the open fields and under greenhouses. Pereira *et al* (2004) [12] indicated to that *A. gossypii* is a serious pest infesting many vegetables crops and its infestation led to direct damage by reducing plant vigor and indirect damage by honeydew secretion and transmission of different viruses.
Plant hormones play an important role in many vital processes in the plants such as controlling of plants growth, development, reproduction and metabolism Peter (2012) [13]. Also David *et al.* (2013) [5] referred to those plant hormones play a serious role in regulation the plant growth and defense by controlling on developmental processes. Bari and Jones (2009) [3] indicated that plant hormones auxins hormone (Indol acetic acid IAA) play a clear role in regulation developmental processes and signaling networks involved in plants.
Lanthanum (La) is one of an important Rare Earth Elements (REEs) which play an important role in many uses Evgenios *et al.* (2018) [7] who also indicated that Lanthanum (La) has been played a wide application in numerous fields in the plants and environment. Christian *et al.* (2015) [4] indicated to the responses of antioxidant systems to lanthanum oxide La2O3 treatments in some plants which led to positive effects on the antioxidant cellular defenses in these plants. Ippolito *et al.* (2011) [10] indicated to the effects of lanthanum element in form lanthanum oxide La2O3 on different plants and referred to that treatment some plants by lanthanum oxide La2O3 led to positive effects on many vital processes of these plants.
The present study aimed to evaluation the efficiency of two different substances on controlling the serious pest *A. gossypii* infesting squash plants *C. pepo* through its effectiveness on its physiological characteristics.

Materials and Methods
Experimental design
Present study was conducted on squash plants *Cucurbita pepo* L. at two different zones (Governorates); Tokh

(Qaliobya Governorate) and Perkash (Giza Governorate) under plastic greenhouses during the period February-March (Summer planting) season 2022. The greenhouse at both of the two zones was covered with double-layered polyethylene and each one was divided into five separated parts with polyethylene wire (1.5mm). First part was left as control whereas it planted with squash planted which did not treat with any substances. Second part was planted with squash planted which treatment by auxins hormone (IAA) low concentration (25 ppm) whereas squash seedlings immersion in the hormone solution for a period 8 hours before planted. Third part was planted with squash planted which treatment by (IAA) high concentration (50 ppm). Fourth part was planted with squash planted which treatment by lanthanum oxide La2O3 low concentration (1 ppm) whereas squash seedlings immersion in the La2O3 solution for a period 8 hours before planted. Fifth part was planted with squash planted which treated by lanthanum oxide La2O3 high concentration (5 ppm). All squash seedlings at the same age and variety were planted from beginning of February month (Summer planting) season 2022. Recommended agricultural processes were conducted similarly at both in the two tested zones and no chemical control was conducted during study. An artificial infestation with *A. gossypii* was done at the same time in both of the two tested zones. Directly counting of successive insect (adults and nymphs stages) was done weekly during the planting period.

Statistical analysis

Mean population numbers of *A. gossypii* (adults and nymphs stages) infesting squash plants and concentrations of the internal substances secreted by that insect were subjected to analysis of variance (ANOVA) and also compared by L.S.D. using SAS program (SAS Institute 1988).

Results and Discussion

Present study aimed to evaluation the efficiency of treatment squash plants by the plant hormone auxins hormone (Indol acetic acid IAA) with two concentrations (25 ppm and 50 ppm) and lanthanum oxide La2O3 also with two concentrations (1ppm and 5ppm) on the infestation level by *Aphis gossypii* Glover through its through its effectiveness on its physiological characteristics.

Population fluctuation of *A. gossypii* infesting squash plants at Qaliobya and Giza governorates during season 2022

Results obtained and tabulated at Table (1) and Fig. (1), (2) show population fluctuations of *A. gossypii* (adults and nymphs stages) infested squash plants at both of Qaliobya and Giza Governorates during season 2022.

Data obtained show that in the first zone Qaliobya Governorate the mean population number of *A. gossypii* infested squash plants did not treatment by any substance (control) was 28.3individual/leaf. While the mean population number of *A. gossypii* which infested squash plants treatment by low and high concentration of the plant hormone auxins hormone (Indol acetic acid IAA) were 18.0, 31.1 individual/leaf respectively. Whereas the mean population number of *A. gossypii* which infested squash plants treatment by low and high concentration of lanthanum oxide La2O3 were 15.1, 32.8 individual/leaf respectively. And for the second zone Giza Governorate the mean population number of *A. gossypii* infested squash plants did not treatment by any substance (control) was 25.4 individual/leaf. While the mean population number of *A. gossypii* which infested squash plants treatment by low and high concentration of IAA were 16.3, 27.8 individual/leaf respectively. Whereas the mean population number of *A. gossypii* which infested squash

Table (1): Population fluctuation of *A. gossypii* infested squash plants at Qaliobya and Giza Governorates during season 2022

Date	Qaliobya Governorate					Giza Governorate				
	Cont.	IAA		La2O3		Cont.	IAA		La2O3	
		25 ppm	50 ppm	1 ppm	5 ppm		25 ppm	50 ppm	1 ppm	5 ppm
1/2/2022	15.5	9.5	18.9	7.8	19.5	13.5	7.5	15.3	5.7	16.5
8/2/2022	19.3	11.1	21.6	9.5	23.3	16.8	9.8	18.5	8.5	19.9
15/2/2022	21.4	13.3	24.8	10.5	26.5	19.5	11.5	22.4	10.1	23.7
22/2/2022	23.5	15.7	26.4	12.7	28.0	21.8	13.8	25.8	12.7	26.3
1/3/2022	27.2	17.5	29.5	14.5	32.5	25.5	15.5	27.3	14.3	28.5
8/3/2022	35.0	21.3	38.6	17.8	40.3	30.3	20.3	32.6	18.1	33.4
15/3/2022	39.3	25.4	41.5	21.5	43.0	35.2	24.2	37.5	20.2	38.7
22/3/2022	45.5	30.5	47.2	26.3	49.1	40.7	27.7	42.9	23.5	43.5
Total	226.7	144.3	248.5	120.6	262.2	203.3	130.3	222.3	113.1	230.5
Mean	28.3	18.0	31.1	15.1	32.8	25.4	16.3	27.8	14.1	28.8
Reduction %	-	36.4	9.1	46.6	13.7	-	35.8	8.6	44.5	11.8
$F_{(0.05)}$	375.84					422.61				
L.S.D	1.045					1.032				

Means within rows bearing different subscripts are significantly different ($P<0.05$) plants treatment by low and high concentration of La2O3 were 14.1, 28.8 individual/leaf respectively.

Data obtained also at the same table and figures indicated to the efficiency of lanthanum oxide La2O3 was higher than the plant hormone auxins hormone (IAA) on decreasing the mean population number of *A. gossypii*. Whereas at Qaliobya Governorate when treatment squash plants by low concentration of La2O3 (1 ppm) the decreasing percentage % of the infestation by *A. gossypii* reach to 46.6% while when these plants treatment by low concentration of IAA (25 ppm) the decreasing percentage % of the infestation by *A. gossypii* reach to 36.4%. And as the same trend was achieved at Giza Governorate while when treatment squash plants by low concentration of La2O3 (1 ppm) the decreasing percentage % of the infestation by *A. gossypii* reach to 44.5% while when these plants treatment by low concentration of IAA (25 ppm) the decreasing percentage % of the infestation by *A. gossypii* reach to 35.8%.

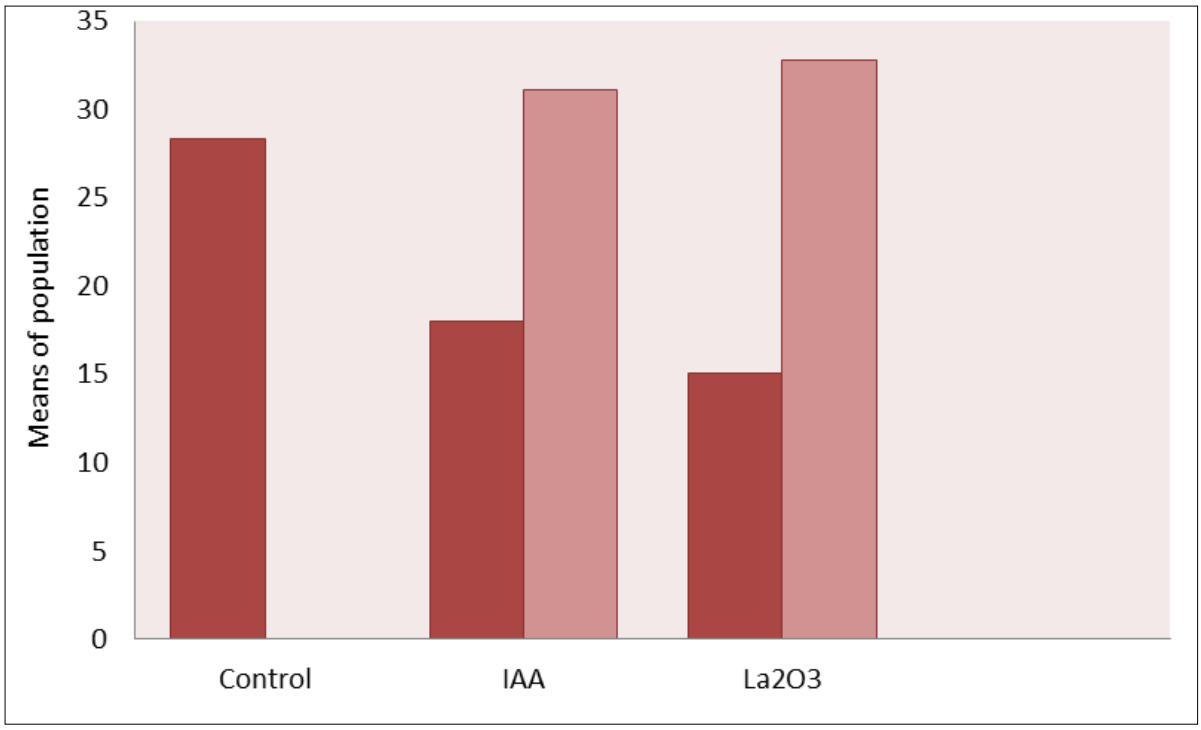

Fig 1: Effectiveness of IAA and La2O3 on the infestation level by *A. gossypii* at Qaliobya Governorate during season 2022

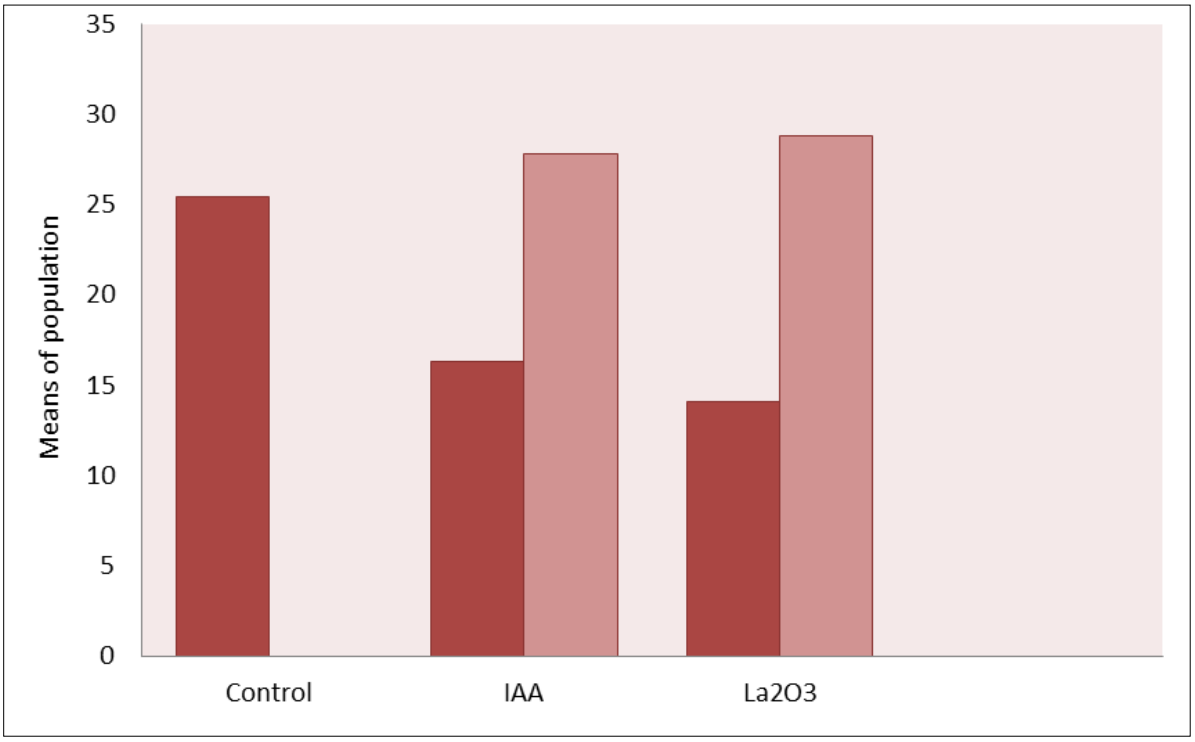

Fig 2: Effectiveness of IAA and La2O3 on the infestation level by *A. gossypii* at Giza Governorate during season 2022

On the other side the high concentration of the two tested substances increasing the infestation percentage % of *A. gossypii* whereas at Qaliobya Governorate when treatment squash plants by high concentration of IAA (50 ppm) increasing the infestation percentage % by the tested pest *A. gossypii* to reach to 9.1% while when treatment squash plants by high concentration of La2O3 (5 ppm) increasing the infestation percentage % by the same insect to reach to 13.7%. Data obtained was achieved as the same trend at Giza Governorate whereas when treatment squash plants by high concentration of IAA (50 ppm) increasing the infestation percentage % by *A. gossypii* to reach to 8.6% while when treatment squash plants by high concentration of La2O3 (5 ppm) increasing the infestation percentage % by the same insect to reach to 11.8%.

Statistical analysis show that were highly significant differences between the mean population number of *A. gossypii* which infesting squash plants were treated by the plant hormone auxins hormone (Indol acetic acid IAA) and lanthanum oxide La2O3 compared to control plants. Whereas at Qaliobya Governorate values of $F_{(0.05)}$ and L.S.D were (375.84, 1.045) respectively while at Giza Governorate values of $F_{(0.05)}$ and L.S.D were (422.61, 1.032) respectively.

Effectiveness of IAA and La2O3 on the physiological characteristics of *A. gossypii* infesting squash plants during season 2022

Data obtained and tabulated on Table (2) show effectiveness of treatment squash plants by both of the plant hormone auxins hormone (Indol acetic acid IAA) and lanthanum oxide La2O3 on the physiological characteristics of the tested pest *A. gossypii*. These physiological characteristics stimulated at the important internal substances secreted by that insect *A. gossypii*. These substances included; two internal compounds: (total proteins - total Lipids); two enzymes: (lipase enzyme - kinase enzyme); two hormones: (molting hormone - juvenile hormone) and two genes: (alpha glucosidase gene - sucrase gene)

Results obtained show that the effectiveness of lanthanum oxide La2O3 was higher than the effectiveness of the plant hormone auxins hormone (IAA) on the physiological characteristics of the tested pest *A. gossypii*. Whereas concentrations of the important internal components secreted by that insect *A. gossypii*; (two internal compounds, two enzymes, two hormones and two genes) decreasing when these insects fed on squash plants treatment by lanthanum oxide La2O3 (1 ppm) more than those insects which fed on squash plants treatment by the plant hormone auxins hormone (IAA) (25 ppm). On the other hand high concentrations of both of the two tested substances; (IAA) 50 ppm and La2O3 (5 ppm) had a positive effectiveness on the tested insect *A. gossypii* whereas concentrations of those internal components secreted by this insect increased compared to control (insects fed on squash plants did treatment by any substance).

Statistical analysis show that were highly significant differences between concentrations of the important internal substances secreted by that insect *A. gossypii* which fed on squash plants treatment by the plant hormone auxins hormone (IAA) and lanthanum oxide La2O3 compared to control (insects fed on squash plants did not treat by any substance).

Table 2: Effectiveness of IAA and La2O3 on the internal substances secreted by *A. gossypii* infesting squash plants during season 2022

Substance	Control	IAA		La2O3		F	L.S.D
		25 ppm	50 ppm	1 ppm	5 ppm		
Total proteins	25.11 ^{a}	22.15 ^{c}	27.33 ^{b}	19.43 ^{c}	29.51 ^{b}	321.56	1.025
Total Lipids	12.46 ^{a}	9.75 ^{c}	15.22 ^{b}	7.85 ^{c}	17.21 ^{b}	277.91	1.033
Lipase Enzyme	29.15 ^{a}	26.44 ^{c}	32.61 ^{b}	24.21 ^{c}	34.82 ^{b}	435.42	1.085
Kinase Enzyme	18.35 ^{a}	15.44 ^{c}	21.16 ^{a}	13.97 ^{c}	23.71 ^{b}	364.88	1.067
Molting hormone	9.5 ^{a}	7.18 ^{c}	12.63 ^{b}	5.52 ^{c}	14.35 ^{b}	411.32	1.092
juvenile hormone	12.4 ^{a}	9.53 ^{c}	15.22 ^{b}	7.23 ^{c}	17.82 ^{b}	298.73	1.081
Alpha glucosidase gene	1.72 ^{a}	1.43 ^{c}	1.96 ^{b}	1.25 ^{c}	2.13 ^{b}	271.99	1.043
Sucrase gene	1.92 ^{a}	1.65 ^{c}	2.26 ^{b}	1.43 ^{c}	2.47 ^{b}	387.22	1.027

Means within rows bearing different subscripts are significantly different ($P < 0.05$)

Obtained results were agreement with those obtained by Ranjan *et al.* (2001) [14] who studied role of auxins hormone on improving the plant healthy and indicated to that auxins represent an important class of plant hormone that regulate plant development. Also, Robert *et al.* (1995) [15] studied role of auxins hormone in biosynthesis and metabolism of some plants and indicated to the important role of these hormones in many vital processes inside plants such as growth and development. Elisabeth and Mark (2009) [6] indicated to that plant hormones (auxins) control on most aspects of the plant life cycle by regulating genome expression. Xingkai *et al.* (2003) [18] indicated to that rare earth element (La) in form lanthanum oxide La2O3 is applied in China to improve crop production. Tandra *et al.* (2018) [17] who indicated to the positive effectiveness of lanthanum element (La) in the cellular systems in many plants. While Leslie (2015) [11] indicated to the negative effectiveness of lanthanum element on different insects through its effectiveness on the nervous system of larval stages and adults of these insects when plants treatment by certain concentrations of this element. Also, Hai *et al.* (2000) referred to the positive effectiveness of lanthanum chloride on lipid peroxidation in rice plants when treatment by it and this led to improving of the plant healthy and controlling some pests infested it. Fashui *et al.* (2003) [8] indicated to the positive effect of lanthanum element in a form lanthanum nitrate on seed germination and growth of rice plants and indicated also to the significantly increase on chlorophyll contents and improving root growth of plants.

Conclusion

Results obtained show that lanthanum oxide La2O3 was more effectiveness on controlling *Aphis gossypii* more than auxins hormone (Indol acetic acid IAA). This is appears and stimulated in decreasing the mean population numbers of the tested insect when squash plants treatment by lanthanum oxide La2O3 more than auxins hormone (IAA) compared to control. Results obtained also indicated to that effectiveness of lanthanum oxide La2O3 was higher than auxins hormone (IAA) on the physiological characteristics of the tested pest *A. gossypii*. These physiological characteristics stimulated at the important internal substances secreted by that insect (eight substances); total proteins, total Lipids, lipase enzyme, kinase enzyme, molting hormone, juvenile hormone, alpha glucosidase gene and sucrase gene. We can recommend by using these substances; lanthanum oxide La2O3 and auxins hormone IAA (with the recommended concentrations in this study) on controlling operations of this serious pest *A. gossypii* (I.P.M) integrated pest management programs.

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