International Journal of Agriculture and Plant Science
www.agriculturejournal.in
Online ISSN: 2664-7664, Print ISSN: 2664-7656
Received: 25-02-2023, Accepted: 15-03-2023, Published: 30-03-2023
Volume 5, Issue 1, 2023, Page No. 70-73

Comparison between effectiveness of gibberellin hormone (GAs) and cytokinin hormone (CKs) on controlling *Tuta absoluta* (Meyrick) infesting tomato plants under greenhouses

Gamila A M Heikal, Abla F A Saad
Plant Protection Research Institute, A.R.C., Dokki, Giza, Egypt

Abstract
This study was carried out to evaluation untraditional methods for controlling the serious pest infesting tomato plants, Tomato leaf miners, *Tuta absoluta* (Meyrick) (Lepidoptera: Gelechiidae). Current study aimed to evaluate some plant hormones, Gibberellin Hormone (GAs) and Cytokinin Hormone (CKs) on controlling and decreasing the population of the successive insect *T. absoluta*. These methods consider modern methods of pest control through the treatment of tomato plants, *Solanum lycopersicum* (Solanales: Solanaceae) by two plant hormones, Gibberellin Hormone (GAs) and Cytokinin Hormone (CKs) - two different concentrations for each hormone - (35 ppm and 50 ppm) on the infestation by Tomato leaf miners, *T. absoluta* at two locations (governorates), Dokki (Giza Governorate) and Tokh (Qaliobya Governorate) during season 2022 under plastic greenhouse. Also, this study was carried out to study effect of treated tomato plants by successive hormones on the some morphological and physiological characteristics of tomato plants. The obtained results indicated that effect of Cytokinin Hormone (CKs) was higher than effect of Gibberellin Hormone (GAs) on the decreasing *T. absoluta* population at tomato plants, also the obtained results indicated that low concentration of both the two successive hormones (35ppm) was higher effectiveness on decreasing population of the successive insect than the high concentration (50 ppm) of the same hormones compared to control. Lastly, obtained results indicated that when treated tomato plants by low concentrations both of the two successive hormones led to positive effectiveness on the morphological and physiological characteristics of tomato plants while when treated tomato plants by high concentrations both of the same hormones led to bad effect on these characteristics compared to control.

Keywords: *Tuta absoluta*, tomato plants, Gibberellin hormone (GAs), Cytokinin hormone (CKs), population, morphological adjectives, internal components

Introduction

Tomato plants (*Solanum lycopersicum*) belong to (Fam.: Solanaceae order: Solanales) consider one of the most important vegetable plants (Neelima 2008) [16]. Tomato plants one of the most important vegetables plants in Egypt which cultivated in different regions in both of the open fields and under greenhouses specially in the reclaimed and recent arias, Goda *et al*. (2015) [8] who reported that tomato plants is one of the most important vegetable plants in Egypt which cultivated annually in 2-3 plantations. Also, Rudich and Atherton (2012) [19] indicated that tomato consider one of the most commercially important crops throughout the world and it is grown in a wide range of climates in the open fields and under protection in plastic greenhouses.

The tomato leafminer, *Tuta absoluta* (Meyrick) (Gelechiidae: Lepidoptera) is one of the serious pests infesting tomato plants in the open fields and under greenhouses (Gabl 2015 and Megido *et al*. 2014) [7, 14]. Also, Desneux (2017) [4] reported that tomato plants is the main host plants of *T. absoluta* and it causes serious injurences to tomato frutes. Also, Bekheit (2011) [2] referred that *T. absoluta* was appeared for the first once in Egypt in 2009 at Nubariya (Behera Governorate). Also, Marcela *et al*. (2005) [12] indicated to Tomato leafminer, *Tuta absoluta* (Meyrick) is one of serious pests of tomato in Argentina since its dispersal in the 1970.

Plant hormones such as Gibberellin hormone (GAs) and Cytokinin hormone (CKs) play important roles in regulating developmental processes and signaling networks involved in plant, Rajendra and Jonathan (2009) [18]. Also, Peter (2012) [17] studied some plant hormones and their role in plant growth and development such as Cytokinin hormone (CKs) and Gibberellin hormone (GAs) and indicated to these plant hormones play a crucial role in controlling the way in which plants grow and development. Emam and Seham (2019) [6] studied effect of Cytokinin hormone (CKs) on cucumber plants and found that hormone improved morphological adjectives of cucumber plants in small concentrations and vice versa in high concentrations.

This study was carried out to study comparison between effect of treated tomato plants by Gibberellin hormone (GAs) and Cytokinin hormone (CKs) on the infestation by Tomato leaf miners, *T. absoluta*.

Materials and methods

Experimental design

Experiments were conducted on tomato plants, Solanum lycopersicum (Fam. Solanaceae - order: Solanales) during season 2022 at two locations (governorates), Dokki (Giza Governorate) and Tokh (Qaliobya Governorate). Tomato seedlings were cultivated at both of the two successive locations (governorates) at the same time at beginning of January month. Experiments were conducted on plastic greenhouse at both of the two successive locations, each plastic greenhouse divided into five parts, first part for control plants (tomato plants which did not treat with any substance), second and third parts of tomato plants which treated with low and high concentrations of gibberellin hormone (GAs) respectively, fourth and fifth parts for tomato plants which treated with low and high concentration

of cytokinin hormone (CKs) respectively. Each part isolated from the other by polyethylene plastic wire (with 0.7 microns). In the first part (treatment) tomato seedlings were cultivated without treated with any hormone. In the second part tomato seedlings were immersion in low concentration of GAs (35ppm) for a period of time 12 hours before planting. Third part tomato seedlings were immersion in high concentration of GAs (50ppm) for a same period of time (12 hours) before cultivated. Fourth part tomato seedlings were immersion in low concentration of CKs (35ppm) for the same long period of time before planting. Fifth part tomato seedlings were immersion in high concentration of CKs (50ppm) the same long period of time before planting. Agricultural operations were conducted on all tomato plants similarly at both of the two successive locations. Recommended agricultural operations were applied and non-chemical control was applied during experiments. An artificial infestation by Tomato leafminers, *T. absoluta* was done at both of the two successive locations at the same time. It is proven accurate observations and directly counting of *T. absoluta* numbers was done weekly at tomato plants during successive season 2022 at both of the two successive locations.

Laboratory design

Laboratory experiments which conducted on tomato plants aimed to observation effectiveness the treatment of tomato plants by the two successive substances (hormones), gibberellin hormone (GAs) and cytokinin hormone (CKs) (two concentrations for each one) on morphological and physiological characteristics of tomato plants. For morphological characteristics which observed or determined were; height of the plant, shoot length and root length comparing to control plants (tomato plants which did not have treatment with any substance). For physiological characteristics which conducted on tomato plants aimed to observed or determine concentration both of: total phenols, amino acids, total proteins and starch comparing control plants.

Determination of total proteins

Total proteins were extracted from tomato leaves (control plants and plants which treated with the two successive hormones) and prepared for determined. 150g of tomato leaves samples were homogeneous in enough water for 10 minutes to obtain suitable homogenate. The tissues were ground in liquid nitrogen with a mortar and pestle according to the method protein content of leaves samples was estimated by spectro-photometricall by the method of Laemmli (1970) [11].

Determination of total carbohydrates and total phenols:

Principle simple carbohydrates, starch, polysaccharides, and their derivatives, including methyl ethers with free or potential free reducing groups, give an orange-yellow color when treated with phenol and sulfuric acid. The reaction is sensitive and the color is stable. Carbohydrates and total phenols content were determined by phenol-sulfuric acid reaction according to Sheri *et al*. (1957) [21].

Statistical analysis

In current study effectiveness of treatment tomato plants with two plant hormones CKs and GAs on the infestation by *T. absoluta* were studied and mean numbers of captured *T. absoluta* males were subjected to analysis of variance (ANOVA) and the means were compared by L.S.D. test at 0.05 level using SAS program (SAS Institute, 1988) [20]

Results and discussion

Data obtained and tabulated in Table (1) indicate to the population fluctuation of *T. obsoluta* infested tomato plants which have treatment with Gibberellin hormone (GAs) and Cytokinin hormone (CKs) (two concentrations) compared to control at Dokki (Giza Governorate) and Tokh (Qaliobya Governorate) during 2022 season.

Table 1: Population fluctuation of *T. absoluta* on tomato plants which had treatment by Gibberellin hormone (GAs) and Cytokinin hormone (CKs) at Giza and Qaliobya Governorates during season 2022

Date	Giza Governorate					Qaliobya Governorate				
	GAs		CKs			GAs		CKs		
	35ppm	50ppm	35ppm	50ppm	Control	35ppm	50ppm	35ppm	50ppm	Control
1/2/2022	13.5 ^{c}	23.9 ^{b}	10.5 ^{c}	23.3 ^{b}	20.5^{a}	12.5 ^{c}	20.1 ^{b}	8.5 ^{c}	20.3 ^{b}	18.7 ^{a}
8/2/2022	15.8 ^{c}	25.8 ^{b}	12.8 ^{c}	26.7 ^{b}	23.7^{a}	14.3 ^{c}	22.3 ^{b}	10.3 ^{c}	23.5 ^{b}	20.5 ^{a}
15/2/2022	17.9 ^{c}	27.9 ^{b}	14.9 ^{c}	28.3 ^{b}	25.3^{a}	16.2 ^{c}	25.4 ^{b}	12.4 ^{c}	25.1 ^{b}	22.3 ^{a}
22/2/2022	19.3 ^{c}	29.8 ^{a}	16.3 ^{c}	30.5 ^{b}	27.5^{a}	17.1 ^{c}	26.1 ^{b}	14.2 ^{c}	27.7 ^{b}	24.2 ^{a}
1/3/2022	20.5 ^{c}	31.7 ^{b}	18.5 ^{c}	32.1 ^{b}	30.2 ^{a}	19.2 ^{c}	27.8 ^{b}	16.8 ^{c}	29.8 ^{b}	25.7 ^{a}
8/3/2022	21.5 ^{c}	34.5 ^{b}	19.3 ^{c}	35.8 ^{b}	32.5 ^{a}	20.7 ^{c}	29.7 ^{b}	19.3 ^{c}	31.3 ^{b}	27.3 ^{a}
15/3/2022	22.6 ^{c}	36.7 ^{b}	21.6 ^{c}	37.2 ^{b}	35.8 ^{a}	22.3 ^{c}	30.9 ^{b}	21.0 ^{c}	33.5 ^{b}	29.2 ^{a}
22/3/2022	25.2 ^{c}	38.5 ^{b}	23.2 ^{c}	39.4 ^{b}	36.5 ^{a}	24.2 ^{c}	33.8 ^{b}	22.4 ^{c}	35.9 ^{b}	32.5 ^{a}
29/3/2022	27.4 ^{c}	40.9 ^{b}	25.4 ^{c}	41.5 ^{b}	38.1 ^{a}	25.7 ^{c}	36.2 ^{b}	24.1 ^{c}	37.7 ^{b}	35.7 ^{a}
5/4/2022	23.5 ^{c}	38.3 ^{b}	21.5 ^{c}	39.1 ^{b}	35.5 ^{a}	21.1 ^{c}	34.5 ^{b}	21.0 ^{c}	33.9 ^{b}	32.8 ^{a}
12/4/2022	21.7 ^{c}	36.9 ^{b}	17.7 ^{c}	37.4 ^{b}	32.7 ^{a}	18.5 ^{c}	32.9 ^{b}	17.2 ^{c}	31.7 ^{b}	29.8 ^{a}
19/4/2022	19.9 ^{c}	32.7 ^{b}	14.9 ^{c}	33.3 ^{b}	29.5 ^{a}	16.3 ^{c}	30.7 ^{b}	13.1 ^{c}	29.6 ^{b}	27.8 ^{a}
26/4/2022	16.6 ^{c}	29.8 ^{b}	12.6 ^{c}	30.8 ^{b}	26.7 ^{a}	14.8 ^{c}	27.5 ^{b}	10.7 ^{c}	27.4 ^{b}	24.7 ^{a}
3/5/2022	14.5 ^{c}	26.9 ^{b}	10.5 ^{c}	27.7 ^{b}	23.2 ^{a}	13.7 ^{c}	25.3 ^{b}	8.8 ^{c}	23.8 ^{b}	20.9 ^{a}
Total	279.9	454.3	239.7	463.1	417.7	256.6	403.2	219.8	411.2	372.1
Mean	19.9	32.5	17.1	33.1	29.8	18.3	28.8	15.7	29.3	26.6
%	33.2	8.3	42.6	10.0	-	31.3	7.6	40.9	9.3	-
F(0.05)	475.37					521.35				
L.S.D	1.045					1.032				

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

Data obtained show that in Giza Governorate the population of *T. absoluta* which infested tomato plants both of treated by low and high concentrations of GAs was 19.9, 32.5 nymph/leaf respectively compared to control which it was 29.8 nymph/leaf, while population of *T. absoluta* which infested tomato plants both of treated by low and high concentration of CKs was 17.1, 33.1 nymph/leaf respectively compared to control which it was 29.8 nymph/leaf. As the same trend was achieved in Qaliobya Governorate whereas population of *T. absoluta* which infested tomato plants both of treated by low and high concentration of GAs was 18.3, 28.8 nymph/leaf respectively compared to control which it was 26.6 nymph/leaf, while population of *T. absoluta* which infested tomato plants both of treated by low and high concentration of CKs was 15.7, 29.3 nymph/leaf respectively compared to control which it was 26.6 nymph/leaf.

Data obtained also show that the effect of Cytokinin hormone (CKs) was higher than Gibberellin hormone (GAs) on decreasing the population of The tomato leaf miners, *T. absoluta* whereas at Giza Governorate when treated tomato plants with low concentration of Cytokinin hormone (CKs) the infestation by the successive insect *T. absoluta* decreased by 42.6% compared to control (tomato plants which did not treat with the successive hormones) while when these plants treated with low concentration of the other successive hormone Gibberellin Hormone (GAs) the infestation by the successive insect decreased by 40.9% compared to control. While when treated tomato plants by high concentration of (CKs) the infestation with *T. absoluta* increased by 10.0% compared to control while when these plants treated with high concentration of the other hormone (GAs) the infestation with *T. absoluta* increased by 8.3% compared to control. And the data obtained was achieved as the same trend at Qaliobya Governorate.

The statically analysis showed that were highly significantly differences between the population of *T. absoluta* which infested tomato plants which treated by different concentrations of GAs and CKs compared to control at both of Giza Governorate and Qaliobya Governorate whereas F(0.05) and L.S.D values in Giza Governorate were (475.37, 1.045) respectively, while F(0.05) and L.S.D values in Qaliobya Governorate were (521.35, 1.032) respectively.

Obtained results were agreement with those obtained by Marta and Frebort (2011) [13] who referred to the importance of CKs (Cytokinin hormone) and its role in pest control and decreasing the infestation with insects when plants have treatment with low concentration. Also, Aron and Paul (2015) [1] indicated to the important role of CKs which played in decreasing the infestation with larvae of *Spilarctia spp.*, Emam and Seham (2019) [6] indicated to the role of the plant hormone CKs on decreasing the infestation by *Aphis gossypii* and *Tetranychus urticae* on cucumber plants when used with special concentrations. And Hayam (2020) [9] studied effect of treated Squash plants by Cytokinin hormone (CKs) (different concentrations) on the infestation by *Bemisia tabaci* and *Tetranychus urticae* and indicated to the role of that hormone in decreasing population of the successive pests when used with special concentrations.

Effect of Cytokinin hormone (CKs) and Gibberellin hormone (GAs) on the important morphological and physiological adjectives of tomato plants

Data obtained and tabulated in table (2) indicate to the effectiveness of treatment tomato plants by Cytokinin hormone (CKs) and Gibberellin hormone (GAs) on the important morphological and physiological adjectives of tomato plants. For morphological adjectives of tomato plants were studied (root lengh, shoot length and the plant height) obtained results indicated that tomato plants when treatment with low concentration of CKs and GAs led to improving these adjectives compared to control. And vice versa, tomato plants when treatment with high concentration of CKs and GAs led to bad effect

Table 2: Effectiveness of treatment tomato plants by Gibberellin hormone (GAs) and Cytokinin hormone (CKs) on the morphological and physiological adjectives of tomato plants season 2022:

Adjective	GAs		CKs		Control	$F_{(0.05)}$	L.S.D
	35 ppm	50 ppm	35 ppm	50 ppm			
Root length (cm)	80.35 c	62.35 b	85.42 c	60.33 b	70.25 a	243.65	1.025
Shoot length (cm)	185.45 c	170.25 b	190.25 c	165.85 b	175.25 a	322.45	1.036
Plant height (cm)	265.80 c	232.50 b	275.67 c	226.18 b	245.50 a	425.37	1.052
Total protein (mg/g)	18.35 c	15.82 b	19.75 c	14.73 b	16.45 a	287.93	1.072
Starch (mg/g)	27.45 c	26.46 b	28.07 c	23.65 b	25.35 a	385.74	1.057
Amino acids (mg/g)	13.15 c	10.53 b	14.63 c	9.75 b	11.25 a	421.83	1.035
Total phenol (mg/g)	11.33 c	8.62 b	12.35 c	7.22 b	9.85 a	298.85	1.057

on these adjectives compared to control And also data was achieved as the same trend for physiological adjectives of tomato plants were studied; (total proteins, starch, total amino acids and total phenols) whereas obtained results indicated that tomato plants when treatment with low concentration of CKs and GAs led to improving these physiological adjectives and vice versa when treated tomato plants with high concentration of these hormones led to bad effect on these adjectives compared to control.

Statistical analysis show that were highly significant differences between effectiveness both of the two successive hormones on the examined adjectives of tomato plants compared to control.

Obtained results were agreement with those obtained by Werner and Schmulling (2009) [23] who studied the metabolism and signalling of hormone cytokinin and indicated to its effect on the regulating growth and improving some morphological characteristics of the examined plants. Marta and Frebort (2011) [13] studied evolution of cytokinin biosynthesis and degradation and indicated to that cytokinin hormones are important regulators of development and environmental responses of plants and also indicated to the hormone role which it played in the improving important physiological characteristics in the tested plants. Miroslav (2015) [15] studied progress in cytokinin research and referred to the

progress of plant biotechnology has stimulated research on the plant hormones and indicated to its effects on the plant development and improving its morphological adjectives. Brecht and Bert (2019) [3] studied the importance of cytokinin hormone in the plant development, and indicated to its effects on developmental processes such as shoot apical meristem, flowers, female gametophyte, stomata and vascular development. Also, Shinjiro (2008) [22] studied gibberellin metabolism and its regulation and refereed to bioactive gibberellins (GAs) are diterpene plant hormones that are biosynthesized through complex pathways and control diverse aspects of growth and development. Eiichi (2005) [5] studied regulation of root growth by plant hormones and indicated to plant hormones such as gibberellin hormone (GAs) are important biotic factors to regulate root growth and it cause a positive effect on the root growing. Jenia *et al*. (2018) [10] studied gibberellin localization and transport in plants and referred to gibberellin hormone (GAs) is a plant hormone regulating key processes in plants; it has a significant agricultural importance in seed germination, root and shoot elongation, flowering and fruit patterning.

Conclusion

Results obtained indicated to the effect of Cytokinin hormone (CKs) was higher than effect of Gibberellin hormone (GAs) on decreasing *T. absoluta* population at tomato plants, also the data obtained showed that low concentration of both the two successive hormones (35ppm) was higher effectiveness on decreasing population of the successive insect than the high concentration (50 ppm) of the same hormones compared to control (tomato plants which did not treat with any hormone). Results obtained indicated also those important morphological and physiological adjectives of tomato plants were improved when treated tomato plants by low concentration both of the two successive hormones while when treated tomato plants by high concentration both of the two successive hormones led to bad effect on these adjectives compared to control.

References

1 Aron M, Paul J. Interactions between cytokinin signalling and abiotic stress responses. Journal of Experimental Botany,2015:66(16):4863-4871.
2 Bekheit HK. *Tuta absoluta* (Tomato borer) outbreak and control measures in Egypt. EPPO/IOBC/FAO/ NEPPO Joint International Symposium on management of *Tuta absoluta* (Tomato borer) Nov,2011:16-18:69.
3 Brecht W, Bert D. Cytokinin-a developing story. Trends in Plant Science,2019:24(2):177-185.
4 Desneux N. Biological invasion of European crops by *Tuta absoluta*: ecology, geographic expansion and prospects for biological control. J. Pest Science,2017:83 (2):197-215.
5 Eiichi T. Regulation of root growth by plant hormones - roles for auxin and gibberellin. Critical Reviews in Plant Sciences,2005:24(4):249-265.
6 Emam AS, Seham A, Ezz El-Dein. Effect of treated cucumber by cytokinin hormone on the infestation of *Aphis gossypii* (Hemiptera: Aphididae) and *Tetranychus urticae* (Acari: Tetranychidae) under glasshouse. Egypt. J. Plant Prot. Res. Inst,2019:2(4):526-533.
7 Gabl L. First report of *Tuta absoluta* (Meyrick) in Austria and first monitoring results. J. Fur Kulturpflanzen,2015:65 (1):1-8.
8 Goda N, El-Heneidy A, Djelouah K, Hassan N. Integrated pest management of the tomato leaf miner, *Tuta absoluta* (Meyrick) (Lepidoptera: Gelechiidae) in tomato fields in Egypt. Egyption Journal of Biology Pest Control,2015:25(3):25-29.
9 Hayam M Saad. Effect of Treated Squash Plants by Cytokinin Hormone (CKs) on the Infestation by *Bemisia tabaci* and *Tetranychus urticae*. Egypt. Acad. J. Biolog. Sci.,2020:13(1):33-40.
10 Jenia B, Roy W, Eilon S. Gibberellin localization and transport in plants. Trends in Plant Science,2018:23(5):410-421.
11 Laemmli UK. Cleavage of structural proteins during the assembly of the head of bacteriophage T4. Nature,1970:15(27):680-685.
12 Marcela M, Botto E, Raul A. Insecticide resistance in argentine population of *Tuta absoluta* (Meyrick) (Lepidioptera: Gelechiidae). Neotropical Entomology,2005:34(2):113-119.
13 Marta K, Frebort I. Evolution of cytokinin biosynthesis and degradation. Journal of Experimental Botany,2011:62(8):2431-2452.
14 Megido R, Haubruge E, Verheggen F. First evidence of *Deuterotokous parthenogenesis* in the Tomato leafminer. *Tuta absoluta* (Meyrick) (Lepidoptera: Gelechiidae). J. Pest Science,2014:85(4):409-412.
15 Miroslav K. Progress in cytokinin research. Trends in Biotechnology,2015:10(3):159-164.
16 Neelima S. Tomato (*Solanum lycopersicum*): a model fruit- bearing crop. Cold Spring Harbor Protocols 2008 (11), Pdb. Emo 105, 2008.
17 Peter J. Plant hormones and their role in plant growth and development. Springer Science and Business Media,2012:25(3):225-235.
18 Rajendra B, Jonathan D. Role of plant hormones in plant defense responses. Plant Molecular Biology,2009:69(3):473-488.
19 Rudich J, Atherton J. The tomato crop: a scientific basis for improvement. Springer Science and Business Media,2012:5(3):225-235.
20 SAS Institute. SAS/STAT User`s Guide, Ver. 6.03. SAS Institute Inc., Cary, North Carolina, 1988.
21 Sheri L, Necolas E, Joanna B. Comparison of protein expressed by *Pseudomonas aeruginosa* strains representing initial and chronic isolated from a cystic fibrosis: an analysis by 2-D gel electrophoresis and capillary liquid chromatography tandem mass spectrometry. Microbiol,1957:146:2495-2508.
22 Shinjiro Y. Gibberellin metabolism and its regulation. Annu. Rev. Plant Biol,2008:59(3):225-251.
23 Werrner T, Schmulling T. Cytokinin action in plant development. Current opinion in plant biology,2009:12(5):527-538.