

## Some observations upon the influence of morphactin IT 3456 applied into the soil on the yield of tomatoes

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### Abstract

It was found that the application of 25 ml of morphactin IT 3456 solution in 0.25; 0.5 and 1 ppm concentrations into 4.8 kg of soil (air dry matter) caused an increase of the total number and weight of fruits in the 'New Yorker' tomato variety. In contrast, a higher dose (50 ml) of the morphactin solution in 5 ppm concentration applied into 4.7 kg of soil (air dry matter) caused a considerable decrease of the number and weight of all fruits, the deformation of fruits and the seasonal blight of plants as well. Morphactin IT 3456 applied into 7.2 kg of pure sand (air dry matter) in 50 ml of the solution in 1 ppm concentration caused much more damage of the plants than observed in the plants grown in the soil treated with the IT 3456 solution in four smaller concentrations.

When 50 ml of morphactin IT 3456 solution in 5 ppm (soil) and 1 ppm (sand) concentration was used, from 74.2 to 100% of parthenocarpy was found. In the remaining combinations development of parthenocarpic fruits was observed sporadically.

### INTRODUCTION

Morphactins affect various physiological and morphogenetic processes in plants. Similarly to other growth regulators the degree of their activity depends on the fluctuation of doses applied and a concentration of solutions and a physiological state of treated plants and the tolerance of the individual species and varieties. Among many different symptoms of the action of the morphactin derivatives — the reduction of apical dominance of the main shoots, the inhibition of cell division in apical meristems, disturbance of the phototropism of hypocotyl and geotropism of roots, the inhibition of transport and the distribution of IAA, the interaction with the phenoxy auxins and other synthetic growth regulators should be mentioned (Khan 1967; Schneider 1970).

The purpose of this work was to determine the influence of different doses of morphactin IT 3456 applied into the soil and sand on the fruit development of the tomatoes grown under conditions of free pollination. Besides, the investigations included some observations on the morphological changes in shoots, leaves and flowers of tomato plants affected by the application of IT 3456 into the soil.

#### MATERIAL AND METHODS

Experiments were carried out on the New Yorker tomato variety, in the greenhouse (Lublin-Felin, April-September, 1973) under conditions of free pollination. The temperature in the greenhouse ranged from 22 to 30°C in the day-time and from 14 to 18°C at night. Tomato seedlings were grown in the sowing boxes to the stage of two cotyledones and then they were transferred to Mitscherlich's pots. The experiment was arranged in completely randomised design in three separate series.

In two series of the experiments, the tomato plants were grown in Mitscherlich's pots filled with 4.7 kg (first series) and 4.8 kg (third series) of soil (air dry matter). However in one (second) series tomatoes were cultivated in 7.2 kg of sand (air dry matter). The soil and sand moisture in the pots were kept on the level of 60% of the full capacity of water.

Before the planting of the seedlings, the sand was mixed with 3.5 g of  $\text{CaCO}_3$ , 0.4 g of ammonium nitrate, 0.3 g of superphosphate, 0.4 g of  $\text{K}_2\text{SO}_4$ , 0.2 g of  $\text{MgSO}_4 \cdot 7\text{H}_2\text{O}$  and traces of microelements: boron, manganese, iron, copper, zinc and cobalt.

The plants grown in the soil were fed weekly with 150 ml/pot of the nutrient solution containing about 0.1 g  $\text{NH}_4\text{NO}_3$ , 0.2 g superphosphate and 0.25 g  $\text{K}_2\text{SO}_4$  and those cultivated in the sand were also fed weekly with the same nutrient solution but applied in about two times higher concentrations.

Morphactin IT 3456 was dissolved in 2-3 ml of ethanol and it was applied to the soil in the water solutions about 7 days before the blooming of the first cluster. In the first and third series of the experiments, 50 ml of the IT 3456 solution/pot in 5 and 1 ppm concentrations was applied, respectively. In the second series, 25 ml of the IT 3456 solution/pot in 0.25, 0.5 and 1 ppm concentrations was used. 8-9 plants for every treatment were used.

At the time of harvest the fruits were counted and weighed separately from each cluster, the total number of fruits, the number of parthenocarpic fruits and average weight of one fruit were also recorded.

## RESULTS

A number of early harvested fruits and the total number of fruits

As can be seen from Table 1 most of fruits developed on the plants treated via roots with the highest (50 ml/pot) doses of the IT 3456 solution applied in 1 ppm (sand) and 5 ppm (soil) concentrations, ripened earlier than those formed on the control plants. The tomatoes grown in the soil treated with 25 ml of IT 3456/pot in 1 and 0.5 ppm concentrations developed earlier from 51.7 to 58.6% of fruits than untreated plants (Table 3).

Table 1

Effect of morphactin IT 3456 applied via roots on ripening of fruits (early yield) in the 'New Yorker' tomato variety. The plants were grown in the soil and sand in Mitscherlich's pots. Averages from eight plants

Kind of soil and its weight (air dry matter) in kg/pot	Dose and concentration of morphactin IT 3456 solution		Number and weight of fruits obtained during the first two harvests (soil-till 29.06; sand-12.07). Average for one plant			
			number of fruits		weight of fruits	
	ml/pot	ppm	in pieces	as % of control =100	in g	as % of control =100
Standard soil 4.7	00.0	1.0	1.0	100.0	40.1	100.0
	50.0	5.0	2.9	290.0	149.3	372.3
Pure sand 7.2	00.0	0.0	2.0	100.0	70.4	100.0
	50.0	1.0	2.4	120.0	82.4	117.0

Tomatoes grown in the soil treated with 50 ml/pot of morphactin IT 3456 solution in 5 ppm concentration formed much fewer fruits (65.6%) at the end of the vegetation season than those grown in the same amounts of untreated soil (Table 2). Similarly, a marked decrease of the total number of fruits (70.3%) in comparison to the control plants was also noticed in the tomatoes cultivated in the sand treated with 50 ml of morphactin IT 3456 solution in 1 ppm concentration.

The decrease of the total number of fruits in these combinations was caused by the abortion of flowers and the inhibition of the general development of plants. Nevertheless, a stronger destructive effect of IT 3456 was observed in the plants grown in the sand than in the plants cultivated in the soil. This was probably due to an easier access of greater amounts of morphactin to the roots than in plants cultivated in soil, where a 4 time higher concentration of the IT 3456 solution was applied.

Table 2

Total number and total weight of fruits harvested during the whole vegetation season from tomatoes (New Yorker cv.) treated via roots with morphactin IT 3456. The plants were grown in the soil and sand in Mitscherlich's pots. Averages from eight plants

Kind of soil and its weight (air dry matter in kg/pot)	Dose and concentration of morphactin IT 3456 solution		Total number and total weight of fruits Averages for one plant			
			number of fruits		weight of fruits	
	ml/pot	ppm	in pieces	as % of control =100	in g	as % of control =100
Standard soil 4.7	00,0	0,0	12.8	100.0	589,0	100.0
	50,0	5,0	4.4	34.4	206,8	35.1
Pure sand 7.2	00,0	0,0	13.1	100.0	431,5	100.0
	50,0	1,0	3.9	29.7	146,6	33.2

Table 3

Effect of morphactin IT 3456 applied via roots on ripening of fruits (early yield) in the 'New Yorker' tomato variety. The plants were grown in 4.8 kg of soil (air dry matter) in Mitscherlich's pots. Averages from nine plants

Dose and concentration of morphactin IT 3456 solution		Number and weight of fruits obtained during the first two harvests (till 3.09) Averages for one plant			
		number of fruits		weight of fruits	
ml/pot	ppm	in pieces	as % of control =100	in g	as % of control =100
00.0	0.00	2.9	100.0	132.3	100.0
25.0	0.25	2.8	96.6	147.2	111.3
25.0	0.50	4.6	158.6	205.7	154.3
25.0	1.00	4.4	151.7	213.4	161.5

Besides, a degradation of IT 3456 in the soil could take place in a shorter time than in the sand which has no practical buffer properties.

Plants grown in the soil treated with 25 ml/pot of the IT 3456 solution in 0.25, 0.5 and 1 ppm concentrations developed from 14.1 to 30.5% more fruits than control plants at the end of the vegetation season (Table 4). Another noteworthy observation seems to be the fact that in the

Table 4

Total number and total weight of fruits harvested during the whole vegetation season from tomatoes (New Yorker cv.) treated via roots with morphactin IT 3456. The plants were grown in 4.8 kg of soil (air dry matter) in Mitscherlich's pots. Averages from nine plants

Dose and concentration of morphactin IT 3456 solution		Total number and total weight of fruits			
		Averages for one plant			
		number of fruits		weight of fruits	
ml/pot	ppm	in pieces <sup>1</sup>	as % of control =100	in g <sup>2</sup>	as % of control =100
00.0	0.00	17.7	100.0	795.6	100.0
25.0	0.25	20.2	114.1	1038.8	130.5
25.0	0.50	20.3	114.6	820.8	103.1
25.0	1.00	23.1	130.5	818.8	102.9

<sup>1</sup> Differences nonsignificant; <sup>2</sup> Differences are significant at  $D_{0.05} = 2.89-3.13$ .

discussed combinations in comparison to the untreated plants an increase of the total number of fruits developed on the first two clusters was noticed. This concerns mostly the plants treated with IT 3456 solution used in 1 ppm concentration (Fig. 1).

Weight of early harvested fruits and the total weight of all fruits.

Shape and colour of fruits

Morphactin IT 3456 used in 50 ml/pot of the water solution in 1 ppm (sand) and 5 ppm (soil) concentrations caused an increase of the early yield and a decrease of the total yield in comparison to the control plants (Table 2). The highest percentage (272.3) of increase of weight of early harvested fruits was observed in plants grown in the soil treated with 50 ml of IT 3456 solution in 5 ppm concentration. However, in the tomatoes grown in the sand treated with 50 ml of the IT 3456 solution in 1 ppm concentration a 17% increase of the weight of early harvested fruits was found in comparison to the control plants. Nevertheless, the weight of all fruits obtained in these combinations at the end of the vegetation season decreased and amounted from 33.2 to 35.1% of that in control plants (Table 2). The fruits in these combinations were altogether deformed and most of them were attacked by blossom-end rot disease (Phot. 1 and Table 5).

Tomatoes grown in the soil treated with 25 ml/pot of morphactin IT 3456 in 0.25, 0.5 and 1 ppm concentrations affected by the action of this compound reacted by an increase of weight of all fruits. This is true especially for the smallest concentration (0.25 ppm) of the IT 3456 solu-

tion. In this combination a 30.5% increase of the total yield was observed, but in other treatments (0.5 and 1 ppm) total yield increased about 3% in comparison to the control plants (Table 4). Moreover, when two highest concentrations of IT 3456 (0.5 and 1 ppm) in this series were applied also, a 54.3-61.5% increase of the early yield in comparison to the control plants was noticed (Table 3). All fruits in this series of experiments had a normal shape and colour typical of the 'New Yorker' tomato variety (Phot. 2).

### Weight of single fruits

The average weight of single fruits harvested both from the plants grown in the soil and in the sand treated with 50 ml of the IT 3456 solu-

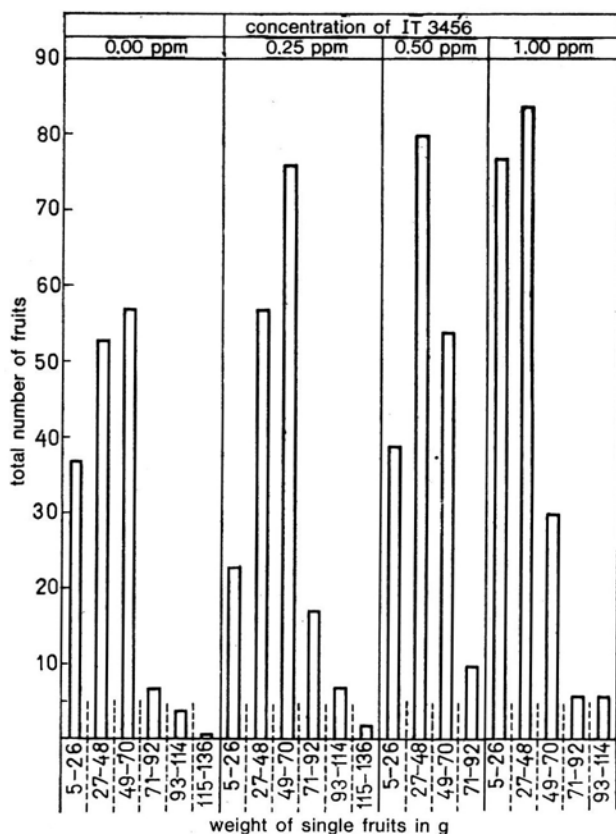
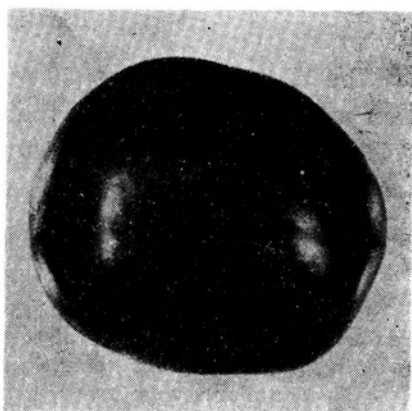
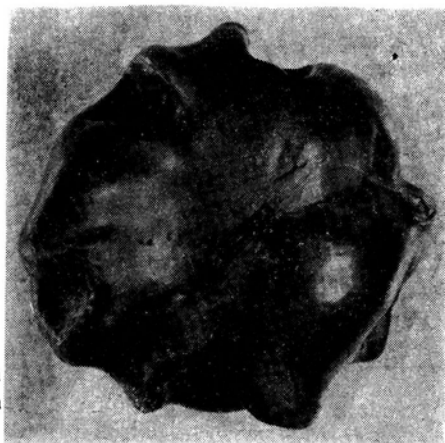


Fig. 1. Effect of morphactin IT 3456 on the weight of single fruits. The plants were grown in the 4.8 kg of soil (air dry matter) treated with 25 ml of the IT 3456 solution



Phot. 1. Fruit from control plant



Phot. 2. Fruit from the plant treated with the IT 3456 solution (50 ml/pot) in 5 ppm concentration

tion in 5 and 1 ppm concentrations was from 3.7 to 15.2% higher than the average weight of control fruits (Table 5).

The IT 3456 solution in 0.5 and 1 ppm concentrations applied into the soil in the amount of 25 ml caused from 10.5 to 21.4% decrease of the average weight of one fruit. However, 25 ml of this compound used in 0.25 ppm concentration evoked a 14% increase of the average weight of fruit in comparison to the fruits harvested from untreated plants (Table 5).

While analysing the number of fruits in different weight groups (Fig. 1), first of all, a marked increase of fruits weighing from 5 to 48 g in the plants treated with the morphactin in 0.5 and 1 ppm concentrations was noticed. On the other hand, IT 3456 applied in a solution in 0.25 ppm concentration caused a considerable increase of the number of fruits weighing from 49 to 136 g in comparison to the control plants (Fig. 1).

## Parthenocarp of fruits

The IT 3456 solutions (50 ml/pot) applied into the sand in 1 ppm concentration caused 100% parthenocarp of fruits. A very high percentage (74.2) of parthenocarp was found also in the plants grown in the soil treated with 50 ml of IT 3456 solution in 5 ppm concentration (Table 5).

Table 5

Parthenocarp as percentage of total number of fruits and average weight of one fruit in the 'New Yorker' tomato variety treated via roots with morphactin IT 3456.

The plants were grown in the soil and sand in Mitscherlich's pots

Kind of soil and its weight (air dry matter) in kg/pot	Dose and concentration of morphactin IT 3456 solution		Total number of fruits (In brackets number of fruits with blossom-end rot)	Parthenocarp as % of total number of fruits	Average weight of one fruit	
	ml/pot	ppm			in g	as % of control = 100
Standard soil <sup>1</sup> 4.7	00.0	0.00	103(12)	00.0	45.7	100.0
	50.0	5.00	35(18)	74.2	47.4	103.7
Pure sand <sup>1</sup> 7.2	00.0	0.00	105(18)	00.0	32.8	100.0
	50.0	1.00	31(17)	100.0	37.8	115.2
Standard soil <sup>2</sup> 4.8	00.0	0.00	159(24)	1.8	45.0	100.0
	25.0	0.25	182(21)	5.4	51.3	114.0
	25.0	0.50	183(14)	4.3	40.3	89.5
	25.0	1.00	208(23)	9.6	35.4	78.6

<sup>1</sup> Data for eight plants; <sup>2</sup> Data for nine plants.

The tomato plants grown in the soil treated with 25 ml of IT 3456 solution in 0.25, 0.5 and 1 ppm concentrations developed in majority normal fruits, containing seeds. Parthenocarp in these combinations ranged only from 4.3 to 9.6%. It is worth mentioning that, parthenocarpic fruits developed mostly on first and second clusters but on the remaining inflorescences parthenocarp was observed sporadically (Fig. 2).

Morphological changes in the growth of tomato plants caused by morphactin IT 3456 applied into the soil and sand

Morphactin IT 3456 applied in amount of 50 ml/pot in 5 ppm concentration (soil) and in 1 ppm concentration (sand) caused a considerable



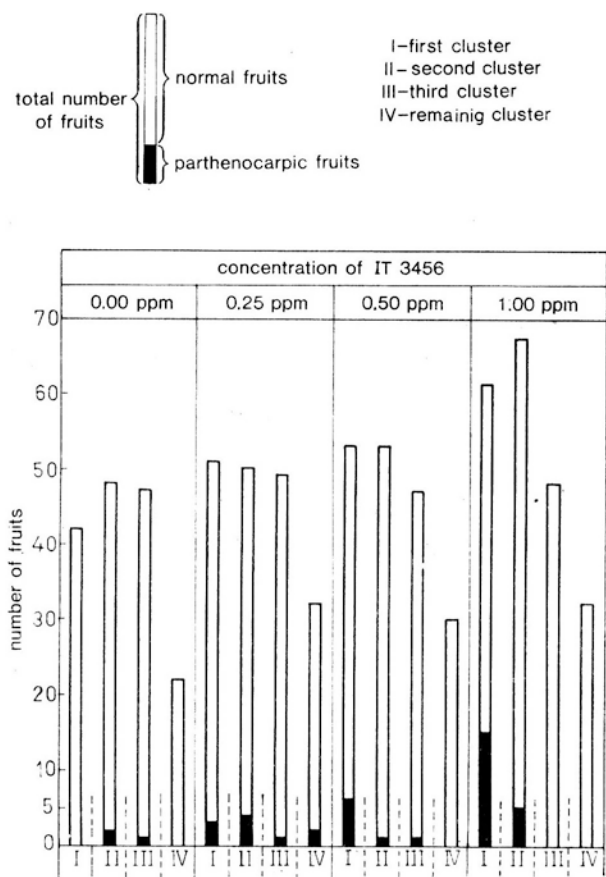


Fig. 2. Effect of morphactin IT 3456 on the development of normal and parthenocarpic fruits on the individual clusters. The plants were grown in 4.8 kg of soil (air dry matter) treated with 25 ml of the IT 3456 solution

deformation of plants. This was expressed in the form of twisted stems and leaf petioles, of the seasonal blight on all plants and frequent abscission of flower buds and developed flowers. Nevertheless, the plants in these combinations were green during the all vegetation season. The beginning of the destructive action of IT 3456 could be observed after a few hours from the moment of the application of this compound. Four to five weeks after treatment there came a gradual decrease of the damaging effect of the morphactin applied into the soil (5 ppm) and sand (1 ppm).

The plants treated with smaller doses of IT 3456 (25 ml/pot) in 0.25, 0.5 and 1 ppm concentrations were developed normally, although in some

of them (mostly in those treated with morphactin in 1 ppm concentration) the symptoms of the short-lasting inhibition of growth were visible.

## DISCUSSION

The data obtained in this report show that the morphactin IT 3456 applied via roots (depending on the concentration and dose as well as on the type of soil) causes a decrease or an increase of the yield of tomatoes. A stimulating or an inhibiting effect of IT 3456 on the development of fruits had a direct connection with the formation of inflorescences, the course of their flowering and fruit settings.

The highest doses in these experiments of the IT 3456 solution (50 ml/pot) applied into the sand (1 ppm) and into the soil (5 ppm) induced the abscission of flower buds and fully developed flowers. As result of this the total number and the total weight of fruits in these combinations decreased. The separation of flower buds and developed flowers were observed in some tomato varieties treated with IT 3456 via leaves in a field and in a greenhouse (Łukasik and Huszcza 1973). Moreover, the abscission of generative and some vegetative organs under the influence of the morphactin treatments was observed in other plants. These loosening effects could be partly counteracted (in *Vitis*) by a simultaneous supply of the auxin 4-CPA (Schneider 1970).

An increase of the total number of fruits observed in the tomato plants treated with the morphactin IT 3456 solution (25 ml/pot) in 0.25, 0.5 and 1 ppm concentrations can be explained on the basis of the stimulating influence of this compound on the development of the ovary without pollination. Parthenocarpy induced by morphactin in tomato flowers after their prior emasculation was first noticed by Schneider (1964). Robinson et al. (1971) found that the morphactin treatments also induced parthenocarpy in cucumbers developing under natural conditions of cultivation fruits with normal seeds. This phenomenon can be considered from the point of view of the physiological changes in the ovary itself, without the help of the growth regulators situated in pollen grain or pollen tubes. On the other hand, morphactin IT 3456, as can be seen from these experiments, also has the ability to induce parthenocarpy under conditions of a free pollination (in intact flowers). In this context a disorder in normal meiotic cells division and in the translocation of auxins and synthesis of cytokinins should be mentioned (Pieńiążek i Saniewski 1967). These growth regulators take part in the mechanism of the parthenocarpic development of the ovary (Audus 1959; Crane 1964; Maciejewska-Potapczykowa 1967; Listowski 1970).

## SUMMARY AND CONCLUSIONS

Experiments were carried out on the 'New Yorker' tomato variety, in Mitscherlich's pots in three separate series.

In two series of the experiments, the plants were grown in standard soil — 4.7 kg (I series) and 4.8 kg (III series) and in pure sand — 7.2 kg (II series). The soil and sand moisture in the pots were kept at 60% of the full capacity of water. The temperature in a greenhouse ranged from 22 to 30°C in the day-time and from 14 to 18°C at night.

Morphactin IT 3456 was applied once in a water solution, about 7 days before the flowering of the first cluster.

The following conclusions are based on the results of the experiments:

1. The morphactin IT 3456 solution applied in amount of 50 ml/pot in 1 ppm (sand) and 5 ppm (soil) concentrations caused a long standing blight on all plants, twisting of stems and leaf petioles and frequent abscission of flower buds and fully developed flowers. The symptoms of the destructive effect of IT 3456 were stronger in the plants grown in the sand than those grown in the soil.

2. As a result of the damage of tomato plants a marked decrease of the total yield was noticed. Moreover, the fruits in these combinations were deformed and often attacked by blossom-end rot disease (Phot. 2 and Table 5). Nevertheless, the early yield in these combinations increased in comparison to the untreated plants (Table 1).

3. Application of the IT 3456 solutions into the soil in amount of 25 ml/pot in 0.25, 0.5 and 1 ppm concentrations exerted a favourable influence on the development of tomatoes. This was expressed mostly by an increase of the early and total yields in comparison to the control plants (Tables 3 and 4). Moreover, in the plants treated with the IT 3456 solution in 0.25 concentration an increase of the average weight of one fruit was observed. This was caused by an increase of number of fruits in groups weighing from 49 to 136 g (Table 5 and Fig. 1).

4. Morphactin IT 3456 applied via roots stimulated the development of parthenocarpic fruits under conditions of a free pollination. The percentage of parthenocarpy in the total number of fruits underwent considerable fluctuations (from 4.3 to 100) depending on the dose and the concentration of IT 3456 used and the type of soil (Table 5).

## REFERENCES

- Audus L. J., 1959. Plant growth substances, Leonard Hill, London.  
Crane J. C., 1964. Growth substances in fruit setting and development in plants, Proc. Nat. Acad. Sci. 45: 1703-1708.

- Khan A. A., 1967. Physiology of morphactins: effect on gravi- and photo response, *Physiol. Plant.* 20: 306-313.
- Listowski A., 1970. O rozwoju roślin, PWRiL, Warszawa.
- Łukasik S., Huszcza W., 1974. Effect of morphactin IT 3456 (methyl-2-chloro-9-hydroxyfluorene-(9)-carboxylate) on parthenocarpic fruit development of tomatoes, *Acta agrobot.* 27 (1): 71-80.
- Maciejewska-Potapczykowa W., 1967. Substancje wzrostowe roślin, PWRiL, Warszawa.
- Pieniążek J., Saniewski M., 1967. Morfaktyny — nowa grupa regulatorów wzrostu, *PNR*, 6: 39-52.
- Robinson R. W., Cantliffe D. J. and Shannon S., 1971. Morphactin induced parthenocarp in cucumber, *Sci.* 171, 3977: 1251-1252.
- Schneider G., 1964. Eine neue Gruppe von synthetischen Pflanzenwachstum — regulatoren, *Naturwissenschaften*, 51: 416-417.
- Schneider G., 1970. Morphactins: physiology and performance, *Ann. Rev. Pl. Physiol.* 21: 499-536.

## Niektóre obserwacje nad wpływem doglebowego stosowania morfaktyny IT 3456 na plonowanie pomidorów

### Streszczenie i wnioski

Badania prowadzono na pomidorach odm. 'New Yorker', w wazonach Mitscherlicha, w trzech oddzielnych seriach.

Jako podłoże uprawowe zastosowano ziemię znormalizowaną w ilości (w przeliczeniu na powietrznie suchą masę) — 4,7 kg (I seria) i 4,8 kg (III seria) oraz czysty piasek w ilości (w przeliczeniu na powietrznie suchą masę) — 7,2 kg (II seria). Wilgotność ziemi i piasku w wazonach utrzymywano na poziomie 60% pełnej pojemności wodnej. Temperatura powietrza w szklarni wynosiła 22-30°C w dzień i 14-18°C w nocy.

Morfaktynę IT 3456 stosowano jednorazowo, w roztworach wodnych, na około 7 dni przed kwitnieniem pierwszego kwiatostanu.

W pierwszej i w trzeciej serii doświadczeń do każdego wazonu wprowadzono 50 ml roztworu IT 3456, odpowiednio o koncentracji 5 i 1 ppm. W drugiej zaś serii, na 1 wazon przeznaczono 25 ml tego związku w stężeniu: 0,25, 0,5 i 1 ppm.

Wyniki uzyskane w niniejszych badaniach pozwalają na wyprowadzenie następujących wniosków:

1. Morfaktyna IT 3456 zastosowana w ilości 50 ml na 1 wazon, w roztworach o koncentracji 1 ppm (piasek) i 5 ppm (ziemia) spowodowała długotrwałe wędnięcie roślin, skręcanie się łodyg i ogonków liściowych, masowe opadanie pączków kwiatowych oraz w pełni wykształconych kwiatów. Destrukcyjne działanie IT 3456 było znacznie silniejsze u roślin uprawianych w piasku niż w glebie.

2. W rezultacie zaburzeń w rozwoju roślin, wywołanych działaniem IT 3456 (1 i 5 ppm), nastąpił znaczny spadek plonu ogólnego (ogólnej liczby i ogólnej masy owoców). Ponadto owoce w tych kombinacjach uległy całkowicie deformacji i większość z nich została porażona suchą zgnilizną wierzchołkową owoców. Równocześnie jednak plon wczesny pomidorów i średnia masa 1 owocu uległy w porównaniu do roślin kontrolnych wyraźnemu zwiększeniu (tab. 1 i 5).

3. Zastosowanie morfaktyny IT 3456 w ilości 25 ml na 1 wazon (ziemia), w

roztworach o koncentracji: 0,25, 0,5 i 1 ppm, wywarło korzystny wpływ na rozwój i plonowanie pomidorów. Wyrażało się to przede wszystkim we wzroście plonu wczesnego i ogólnego owoców w porównaniu do roślin kontrolnych (tab. 3 i 4). Niezależnie od tego, u roślin traktowanych roztworem IT 3456 o koncentracji 0,25 ppm, zaobserwowano w porównaniu do pozostałych kombinacji, wzrost średniej masy 1 owocu, głównie w rezultacie wzrostu liczby owoców o najwyższej masie (w grupach od 71 do 136 g) — tabela 5 i rysunek 1. Przy stosowaniu zaś roztworów IT 3456 o koncentracjach 0,5 i 1 ppm, średnia masa 1 owocu uległa zmniejszeniu w porównaniu do roślin kontrolnych.

4. Morfaktyna IT 3456 stymulowała rozwój owoców partenokarpicznych w warunkach swobodnego zapylania kwiatów. Procent partenokarpii w ogólnej liczbie owoców ulegał jednak znacznym wahaniom, zależnie od wysokości dawki i koncentracji roztworów IT 3456 oraz od rodzaju podłoża uprawowego. W kulturach piaskowych, 50 ml dawka IT 3456 o koncentracji 1 ppm wywołała 100% partenokarpie owoców. Podobnie wysoki procent partenokarpii (74,2) zaobserwowano u roślin traktowanych 50 ml IT 3456 o koncentracji 5 ppm. W pozostałych kombinacjach partenokarpia owoców występowała sporadycznie (tab. 5).

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