UDC 635.63:632.9:631.544.43

Adjusters of growth of plants as a possible factor of protection of a cucumber against fungous disease

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The purpose. To justify an opportunity of application of adjusters of growth of plants (AGP) on the basis of humic acids, biologically active substances and complex microfertilizer KompleMet against diseases of plants of a cucumber. **Methods.** Laboratory — study of effect of AGP on development of the causal organism of root rots secreted from plants of cucumber — fungus Fusarium solani App. et Wr. in crop in vitro (according to V.I. Bilay, 1982). Field experiments on determination of efficiency of AGP were led according to S.A. Tribel's technique (2001). **Results.** It is established that fungus Fusarium solani App. et Wr. is the most susceptible to AGP on the basis of biologically active substances: Epin extra, salicylic and amber acids. Their inhibiting effect on the 3rd day had made 36.7; 56.7, and 33.3% accordingly. Integrated data of field probes confirmed that the highest efficiency against root rots had the alternative with application of microfertilizer KompleMet (K1+M1) — 60%. Efficiency of AGP on the basis of biologically active substances was below and made 55 – 52%. Efficiency of humic specimen Vympel Maxi was at the same level — 56%. Treatment of plants with AGP promoted lowering of the level of strikeness of plants of a cucumber with false mildew. Due to activation of growth processes at plants and presence of antifungal activity against causal organisms of diseases introduction in technique of growing of plants of cucumber of AGP made active reward payment of the crop. The increase of productivity had made 1.06 – 2.50 kg/m2. **Conclusions.** AGP on the basis of biologically active substances (Epin extra, salicylic and amber acids) essentially suppress growth of fungus Fusarium solani App. et Wr. in crop in vitro. AGP on the basis of humic substances and complex microfertilizer KompleMet (K1+M1) did not manifest stopping power activity. So, to increase efficiency it is necessary to search an opportunity of specimens to promote activation of nonspecific protective responses in plants. In sowings of a cucumber in film hothouses it is expedient in order to lower intensity of root rots to apply complex microfertilizer KompleMet (K1+K2) in dose of 1 l/hectare or one of AGP: on the basis of biologically active substances — salicylic acid (0.1 kg/hectare) or Epin extra (0.08 l/hectares); on the basis of humic substances — Vympel Maxi (1 l/hectare). Application of AGP in technique of growing of a cucumber ensures increase of productivity on 1.06-2.50 kg/m^2.

Key words: *film hothouses, diseases of a cucumber, adjusters of growth of plants, efficiency.*
DOI: https://doi.org/10.31073/agrovisnyk201908-05

Today it has been proven that uncontrolled (unsystematic) use of chemical plant protection measures instead of improving the phytosanitary condition leads to a fundamentally opposite effect, namely, emergence of resistance in pests populations, increased environmental pollution, negative environmental and sanitary-hygienic consequences. In addition, first of all, the structure and the regulating function of biocenoses change, which affects an acute decrease in their self-regulating ability, and pesticide residues quickly accumulate in all parts of the food chain, as well as in soil, water and air.

Therefore, the development of pesticide-free biologically-oriented technologies for the cultivation of vegetable crops is a prospective area of research.

This problem is particularly relevant for greenhouses conditions, as well as its specific conditions – limited species and varietal set of plants, continuous use of soil, and limitations on the use of effective chemical plant protection products (pesticides using in greenhouses is limited and regulated by the Law of Ukraine On Pesticides and agrochemicals (Article 13)) leads to accumulation and spreading in such conditions a significant amount of pathogens and pest.

A review of the current state of research to the problem of protecting plants allows to conclude that biological method of controlling harmful organisms is perspective. Moreover, it has been proven that the use of biological preparations increased the yield of vegetable plants, reduces the negative toxic effect to them and makes it possible to get environmentally safe products [1-7].

Nowadays, the role of plant growth regulators is constantly growing in agriculture. It is known that plant growth regulators be able to regulate plant metabolism, affecting membrane permeability, ion

transport, photosynthesis, ATP synthesis and activity of many enzymes. There is enough evidence that their use promote to induction of root formation, regulation of sex flowering and maturation, and increase resistance to pests and diseases [8–11].

The introduction of growth regulators to the plant protection system is based on their ability to restrain the development of diseases, increasing plant resistance by activating metabolic processes. In addition, some plant growth regulators directly affect pathogens, showing antibacterial and fungicidal activity. In recent years, widely used drugs such as Emistim, hydroxycinnamic acids, humates, Agat 25K and others that are allowed for use in Ukraine [12].

The purpose of the research is to substantiate the possibility of using plant growth regulators based on humic acids, biologically active substances and complex microfertilizer CompleMet against cucumber plant diseases.

Materials and methods. Study was conducted in the film greenhouses of the laboratory of vegetable growing in protected soil of the Institute of Vegetable and Melon Growing NAAS during 2016-2018. to determine the effectiveness of growth regulators and complex fertilizer against diseases in the cultivation technology of parthenocarpic type cucumber.

Plant growth regulators (PGRs) based on humic substances were used – Hydrogumin, Gulliver Stimul, Vympel Maxi; on the basis of biologically active substances – Epin extra, salicylic and succinic acids and complex microfertilizer CompleMet (K1 + M1).

The fungicidal action of PGR was studied in laboratory and field researches for parthenocarpic cucumber hybrid Lyric F_1 according to generally accepted methods [13-15].

Laboratory experiments included the study of the effect of these PGRs on the development of the root rot fungus *Fusarium solani* App et Wr., isolated from cucumber's plants in vitro culture. The culture of the fungus was grown at a temperature of 23 °C and a 12-hour daylight on the Czapek medium supplemented with PGR at the recommended concentrations. Linear growth of the colonies was analyzed on the third and fifth day.

Field experiments included the study of the effectiveness of PGRs in the protection of cucumber plants against diseases. Plants were treatmented with regulators in 4 stages: soaking seeds (exposure time-12 hours) and spraying plants 3 times in the ontogeny phases of 3-4 true leaves, the beginning of flowering and the beginning of fruiting. The effectiveness of measure was analyzed by the intensity of disease development according to generally accepted methods. The standard was an aqueous solution of PGR Hydrogumin (1.5 l/ha). In the control variant, seeds were soaked and plants were sprayed with clean water.

Pathogens of diseases were identified using manual of N. M. Pidoplichko [16].

Results. Monitoring studies of the cucumber agrocenosis and a microscopic analysis of the symptoms of the lesion made it possible to identify the causative agents of cucumber plant diseases in the conditions of film greenhouses. It was established that the plants affected in all phases of ontogenesis. In the phase of 3-4 leaves, plants are affected by root rot. The dominant role in the development of this disease belonged to the fungi of the genus Fusarium sp.: *Fusarium oxysporum f. sp. cucumerinum* J.H. Owen, *Fusarium solani* App. et Wr., *Fusarium culmorum* (W.G.Sm) Sacc. Later, during the period of mass fruiting, disease manifested itself in the form of the wilting of cucumber plants. In the years of research, the spreading of the disease was up to 25% with an intensity of up to 15%. Starting from the ontogenesis phase – the beginning of flowering – it was recorded a single defeat of plants by viruses and angular bacterial spot, the pathogen – bacterium *Pseudomonas syringae pv. lachrymans* Smith et Bryan. The further analysis of the development of bacterial and viral diseases in the conditions of film greenhouses is shown that they did not have economic value. During mass fruiting, the symptoms of downy mildew were recorded annually, the causative agent – fungus *Pseudoperonospora cubensis* Rostowz. The intensity of the disease development during observation period reached 82.1-88.1 %, which indicates about its epiphytotic development, which later caused an almost complete cessation of fruiting and premature death of plants. So, the most harmful and economically significant diseases of cucumber plants in greenhouses are root rot and downy mildew.

To determine the fungicidal action of the above growth regulators, a series of experiments in vitro were carried out at the first stage. It has been established that the *Fusarium solani* App. et Wr. showed the greatest susceptibility to PGRs on the basis of biologically active substances: Epin extra, salicylic and succinic acids. Their inhibitory activity on the third day was 36.7, 56.7, and 33.3%, respectively. Moreover, their ability to delay the beginning of fungal sporulation for 2-6 days was revealed. Growth regulators based on humic substances (except Hydrogumin) and complex microfertilizer CompleMet did not show inhibitory activity on the development of the mycelium of the fungus *Fusarium solani* App. et Wr. Moreover, the inhibitory effect of Hydrogumin could be observed for the first three days afterwards it was leveled (Table 1).

1. The effect of plant growth regulators on colony growth of Fusarium solani App. et Wr.

Variant	Concentration of PGRs for 100 mL medium	Colony diameter, mm		Inhibitory activity, %		Beginning of sporulation, day
		3th day	5th day	3th day	5th day	
1. Treatment with water (control)	-	30	44	-	-	3
PGR based on humic substances						
2. Hydrogumin (standard), mL	0,2	26	46	13,3	-4,5	3
3. Gulliver Stimul, mL	0,1	31	45	-3,3	-2,3	3
4. Vympel Maxi, mL	0,25	33	47	-10,0	-6,8	3
PGR based on biologically active substances						
5. Salicylic acid, mg	10	20	38	33,3	13,6	8
6. Succinic acid, mg	10	13	24	56,7	45,5	9
7. Epin extra, mL	0,025	19	21	36,7	52,3	5
Complex microfertilizer						
8.CompleMet (K1+M1), mL	0,6+0,3	33	53	-10,0	-20,5	3

The generalized data of field studies of effectiveness of the measure have been confirmed that the highest efficiency against root rot was provided with using microfertilizer CompleMet (K1 + M1) – 60%. The effectiveness of growth regulators based on biologically active substances was lower and amounted to 55% in the variant with salicylic acid and 52% in Epin extra. At the same level was the effectiveness of the humic drug Vympel Maxi – 56%. Growth regulators Gulliver Stimul and succinic acid with an efficiency of 42-43% (Table 2) turned out to be close to the standard (Hydrogumin). The treatment of plants with growth regulators promotes to reduction in the level of infestation of cucumber plants with downy powdery mildew. So the least progression of the disease was noted using Vympel Maxi, Epin extra and CompleMet – 8.5% with 13.7% in the control, i.e. the effectiveness of PGRs does not exceed 38%. Variants with using PGRs based on biologically active substances – salicylic and succinic acids has an efficiency 26%.

2. ***Effectiveness of protection measures against plant diseases on cucumber hybrid Lyric F_1 (average for 2016-2018)***

Variant	Root rot		Downy mildew		Yield, kg / m^2	Yield increase kg / m^2
	disease development, %	efficiency, %	disease development, %	efficiency, %		
1. Treatment with water (control)	30,5	-	13,7	-	13,22	

PGR based on humic substances						
2. Hydrogumin (standard), 1,5 l/ ha	17,5	43	11,3	18	14,28	1,06
3.Gulliver Stimul, l/ ha	17,7	42	13,8	-1	14,85	1,63
4. Vympel Maxi, l/ ha	13,3	56	8,5	38	14,90	1,70
PGR based on biologically active substances						
5. Salicylic acid, 0.1 kg/ga	17,3	43	10,2	26	14,35	1,13
6. Succinic acid, 0.1 kg/ga	13,6	55	10,2	26	14,94	1,72
7. Epin extra, 0.08 l/ ha	14,7	52	8,5	38	15,50	2,30
Complex microfertilizer						
8. CompleMet, 1 l/ ha	12,3	60	8,5	38	15,70	2,50
HIP_{05} 2016 2017 2018	12,5 9,5 20,7		1,5 2,1 8,8			

It is important that the difference in the intensity of downy mildew development according to variants manifested itself within 10 days from the moment of detection of the first signs of disease. Further, with an increase in the intensity of the development of the disease, the difference between the variants leveled out. This suggests that plant growth regulators are able to restrict the spreading and development of downy mildew only in the initial stages of the disease.

Due to the activation of growth processes in plants and the presence of fungicidal activity in relation to pathogens, the introduction of PGRs in the technology of growing plants of cucumber activated the yield of the crop. The yield increase due to the effect of PGRs and complex fertilizer CompleMet ranged from 1.06 to 2.50 kg / m^2. The highest rate provided the use of complex fertilizer CompleMet – 2.50 kg / m^2. Among the PGR based on biologically active substances, the best were: salicylic acid and Epin extra – 1.72 and 2.30 kg / m^2, respectively; on the basis of humic substances: Gulliver Stimulus and Vympel Maxi – 1.63 and 1.70 kg/m^2.

Conclusions

Plant growth regulators based on biologically active substances (Epin extra, salicylic and succinic acids) significantly inhibit the growth of the causative agent of root rot of cucumber plants – the fungus Fusarium solani App. et Wr in vitro culture and delayed the beginning of sporulation for 2-6 days. Plant growth regulators based on humic substances and complex microfertilizer CompleMet (K1 + M1) do not show inhibitory activity on the development of the mycelium of the fungus Fusarium solani App. et Wr. Improving the effectiveness of the measures should be searched in the ability of preparations to promote the activation of non-specific protective reactions and, as a consequence, non-specific plant resistance to biotic factors.

For reducing intensity of cucumber root rot in film greenhouses, it is advisable to use the complex microfertilizer CompleMet (K1 + K2) 1 l/ha or one of the plant growth regulators: on the basis of biologically active substances, salicylic acid (0.1 kg/ha) or Epin extra (0.08 l/ha); on the basis of humic substances – Vympel Maxi (1 l/ha).

The using of growth regulators in the technology of growing cucumber plants provides an increase in yield from 1.06 to 2.5 kg/m^2.

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