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Auxin-like effect of derivatives of Pyrimidine, Pyrazole, Isoflavones, Pyridine, Oxazolopyrimidine and Oxazole on acceleration of Vegetative growth of Flax

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Abstract : The comparative analysis of the stimulating effect of low molecular weight heterocyclic compounds, derivatives of pyrimidine, pyrazole, isoflavones, pyridine, oxazolopyrimidine, oxazole and plant hormones auxins IAA (1*H*-Indol-3-ylacetic acid) and NAA (1-Naphthylacetic acid) on germination of seeds and growth of seedlings of flax (*Linum usitatissimum* L.) cultivars Ukrainian 3 and Svitanok was conducted. The specific auxin-like stimulating effect of chemical heterocyclic compounds on the basic processes of flax seedlings growth: cell division, cell proliferation, cell elongation and cell differentiation was found. The growth parameters of flax seedlings grown on water solution of chemical heterocyclic compounds used at the concentrations 10^{-8}M and 10^{-9}M were similar or higher of the growth parameters of flax seedlings grown on distilled water (control) or on water solution of auxins IAA and NAA used at the same concentrations 10^{-8}M and 10^{-9}M. The obtained results proved the possibility of practical application of derivatives of pyrimidine, pyrazole, isoflavones, pyridine, oxazolopyrimidine and oxazole for intensification of vegetative growth of flax.

Keywords: *Linum usitatissimum* L., auxins IAA and NAA, pyrimidine, pyrazole, isoflavones, pyridine, oxazolopyrimidine, oxazole.

1. Introduction

Flax (*Linum usitatissimum* L.) is one of the important oil and fiber crops cultivated in more than 20 world countries[1,3]. Flax is widely used to produce cellulosic fiber for textile and paper industry and seed oil for food, cosmetic and pharmaceutical industry[3-5]. Flax seed lignan secoisolariciresinol diglucoside (SDG) and seed oil which contains more than 50 % of omega-3 fatty acid-α-linolenic acid (ALA), sterols and tocopherols are used as supplements to dietary food and as pharmaceutical drugs for treatment of different

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diseases: weight gain, heart disease, hypertension, atherosclerosis, diabetes, arthritis, memory problems, depression, cancer, inflammatory diseases, kidney disorders[3-5]. Moreover flax oil has polymer-forming properties due to high content of linolenic acid; therefore it is an ideal raw material for manufacture of paints, varnishes and ink[4,6,7].

During the last decades the plant growth regulators of natural or synthetic origin, organic and mineral fertilizers, and vitamins are widely used in the agricultural and biotechnological practice to improve the growth and development of flax during vegetative stage[8-13]. The new promising approach is elaboration of new plant growth regulators having specific to flax (*Linum usitatissimum* L.) activity and lack of toxic effect for environment, animal and human health. In recent years the considerable attention is focused on practical application in the agriculture of different classes of low molecular weight heterocyclic compounds, derivatives of pyrimidine, pyrazole, isoflavones, pyridine, oxazole, oxazolopyrimidine as effective substitutes of traditional plant growth regulators, herbicides, fungicides and antimicrobial agents[14-26]. Testing of different classes of chemical low molecular weight heterocyclic compounds on human and animal cells indicated their activity against cancer, viral, bacterial, fungal, infectious, inflammatory and nervous diseases[27-31].

Today the new low molecular weight five and six-membered heterocyclic compounds that exhibit a wide range of biological activity on human and animal cells are synthesized in the Institute of Bioorganic Chemistry and Petrochemistry of National Academy of Sciences of Ukraine[32-39]. Our previously conducted screening of new effective plant growth regulating substances among different classes of chemical low molecular weight heterocyclic compounds showed that most tested chemical heterocyclic compounds revealed a high stimulating effect on growth and development of various agricultural crops during vegetative stage[40-44]. We found also that some low molecular weight heterocyclic compounds, derivatives of pyridine, pyrimidine, pyrazole and isoflavones showed a high stimulating effect on organogenesis of shoots and roots in the isolated tissue cultures of flax (*Linum usitatissimum* L.) cultivar heavenly grown under *in vitro* conditions[45]. Based on the results of our numerous researchers the elaboration of new effective regulators on the base of different classes of chemical low molecular weight heterocyclic compounds for improving of vegetative growth of flax (*Linum usitatissimum* L.) is very promising approach.

The main task of the present work was study of the stimulating effect of chemical low molecular weight heterocyclic compounds, derivatives of pyrimidine, pyrazole, isoflavones, pyridine, oxazolopyrimidine and oxazole in comparison with the stimulating effect of plant hormones auxins IAA (1*H*-Indol-3-ylacetic acid) and NAA (1-Naphthylacetic acid) on growth of seedlings of flax (*Linum usitatissimum* L.) cultivars Ukrainian 3 and Svitanok.

2. Materials and methods

2.1. Plant treatment and growing conditions

The seeds of flax (*Linum usitatissimum* L.) cultivars Ukrainian 3 and Svitanok were surface sterilized by 1 % $KMnO_4$ solution for 3 min followed by treatment with 96 % ethanol solution for 1 min, and then washed three times with sterile distilled water. After this procedure wheat seeds were placed in the cuvettes (each containing 20-25 seeds) on the perlite moistened with distilled water (control), or with solution of chemical heterocyclic compounds, derivatives of pyrimidine, pyrazole, isoflavones, pyridine, oxazolopyrimidine, oxazole used at the concentrations 10^{-8}M and 10^{-9}M or plant hormones auxins IAA (1*H*-Indol-3-ylacetic acid) and NAA (1-Naphthylacetic acid) used at the same concentrations 10^{-8}M and 10^{-9}M. Afterward, the control and experimental flax seeds were placed in the thermostat for their germination in the darkness at the temperature 25 °C during 48 hours. Sprouted flax seedlings were placed in the growth chamber where seedlings were grown for 15 days (flax cultivar Ukrainian 3) or 20 days (flax cultivar Svitanok) at the 16/8 h light/dark conditions, at the temperature 24 °C, light intensity 3000 lux and air humidity 60-80 %. The comparative analysis of the growth parameters of the flax seedlings (i.e. number of germinated seeds (%), length of shoots (cm), total number of roots (pcs), total length of roots (mm)) was carried out on the 15^{th} or 20^{th} days after their sprouting according to the guideline[46].

2.2. Statistical analysis

All experiments were performed in three replicates. Statistical analysis of the data was performed using dispersive Student's-t test with the level of significance at $P \leq 0.05$, the values are mean ± SD[47].

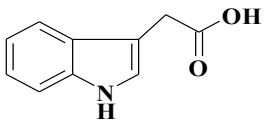
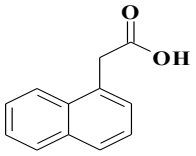
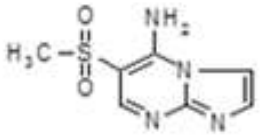
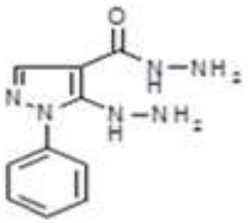
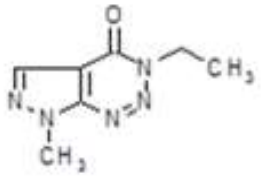
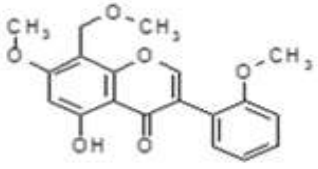
3. Results and Discussion

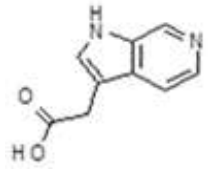
3.1. Study of stimulating effect of derivatives of pyrimidine, pyrazole, isoflavones and pyridine on growth of flax (*Linum usitatissimum* L.) cultivar Ukrainian 3

The comparative analysis of stimulating effect of plant hormones auxins IAA and NAA, and chemical heterocyclic compounds, derivatives of pyrimidine, pyrazole, isoflavones and pyridine on growth of flax (*Linum usitatissimum* L.) seedlings cultivar Ukrainian 3 was conducted.

The chemical structure, chemical name and molecular mass (MM) of plant hormones auxins IAA (1*H*-Indol-3-ylacetic acid) and NAA (1-Naphthylacetic acid), and tested chemical heterocyclic compounds, derivatives of pyrimidine (compound № 1), pyrazole (compounds № 2 and № 3), isoflavones (compound № 4) and pyridine (compound № 5) are shown in the Table 1.

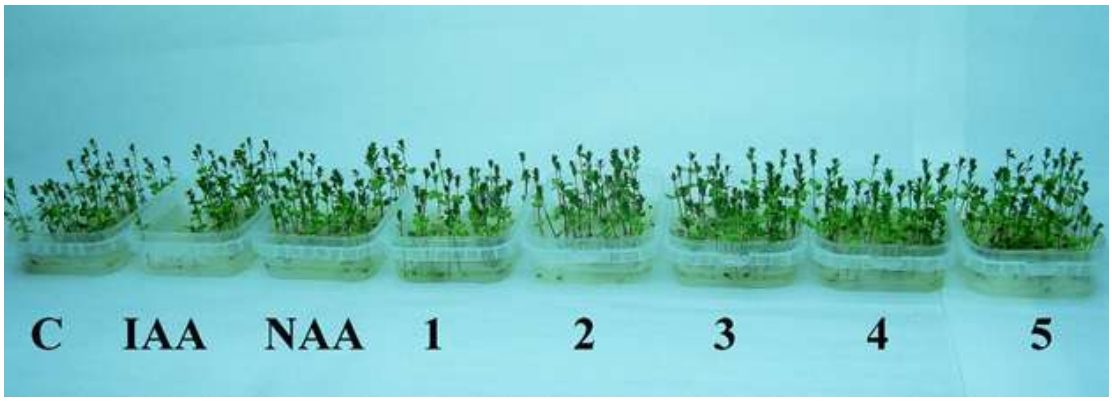
Table 1: Chemical structure of plant hormones and chemical heterocyclic compounds, derivatives of pyrimidine, pyrazole, isoflavones and pyridine

№	Chemical structure of compounds	Chemical name and relative molecular mass of compounds
IAA		IAA (1*H*-Indol-3-ylacetic acid), MM 175.19
NAA		NAA (1-Naphthylacetic acid), MM 186.21
1		6-Methanesulfonyl-imidazo[1,2-*a*]pyrimidine-5-ylamine, MM 212.23
2		5-Hydrazino-1-phenyl-1*H*-pyrazole-4-carbohydrazide, MM 232.25
3		3-Ethyl-7-methyl-3,7-dihydro-4*H*-pyrazolo[3,4-*d*] [1,2,3]triazin-4-one, MM 179.18
4		5-Hydroxy-7-methoxy-8-(methoxymethyl)-3-(4-methoxyphenyl)-4*H*-chromen-4-one, MM 342.35

5		((1*H*-pyrrolo[2,3-*c*]pyridin-3-yl)-acetic acid), MM 176.175

It was found that all chemical heterocyclic compounds used at the concentration of 10^{-8}M showed auxin-like stimulating effect on growth and development of shoot and root system of the flax seedlings during 15 days (Figure 1, A and B).

A



B

Figure 1: Stimulating effect of auxins IAA (1*H*-Indol-3-ylacetic acid) and NAA (1-Naphthylacetic acid) and chemical heterocyclic compounds, derivatives of pyrimidine (compound №1 - 6-Methanesulfonyl-imidazo[1,2-*a*]pyrimidine-5-ylamine), pyrazole (compound №2 - 5-Hydrazino-1-phenyl-1*H*-pyrazole-4-carbohydrazide and compound №3 - 3-Ethyl-7-methyl-3,7-dihydro-4*H*-pyrazolo[3,4-*d*][1,2,3]triazin-4-one), isoflavones (compound №4 - 5-Hydroxy-7-methoxy-8-(methoxymethyl)-3-(4-methoxyphenyl)-4*H*-chromen-4-one), pyridine (compound №5 – ((1*H*-pyrrolo[2,3-*c*]pyridin-3-yl)-acetic acid) on growth and development of shoot system (A) and root system (B) of the 15th-day-old flax seedlings cultivar Ukrainian 3 as compared to control (C) flax seedlings grown on the distilled water

The comparative analysis of the biometric indices (i.e. number of germinated seeds (%), length of shoots (cm), total number of roots (pcs), total length of roots (mm)) showed that the biometric indices of 15th-day-old flax seedlings cultivar Ukrainian 3 grown on water solution of heterocyclic compounds, derivatives of pyrimidine, pyrazole, isoflavones and pyridine used at the concentration 10^{-8}M were higher of the biometric indices of flax seedlings grown on water solution of auxins IAA and NAA used at the same concentration 10^{-8}M and control flax seedlings grown on distilled water in average: according with length of shoots – at the 5-7 % as compared with control; according with total length of roots – at the 15–58 %, 3-20 %, 11–15 % as compared with control, IAA, and NAA, respectively; according with total number of roots – at the 39–67 % as compared with control (Figure 2).

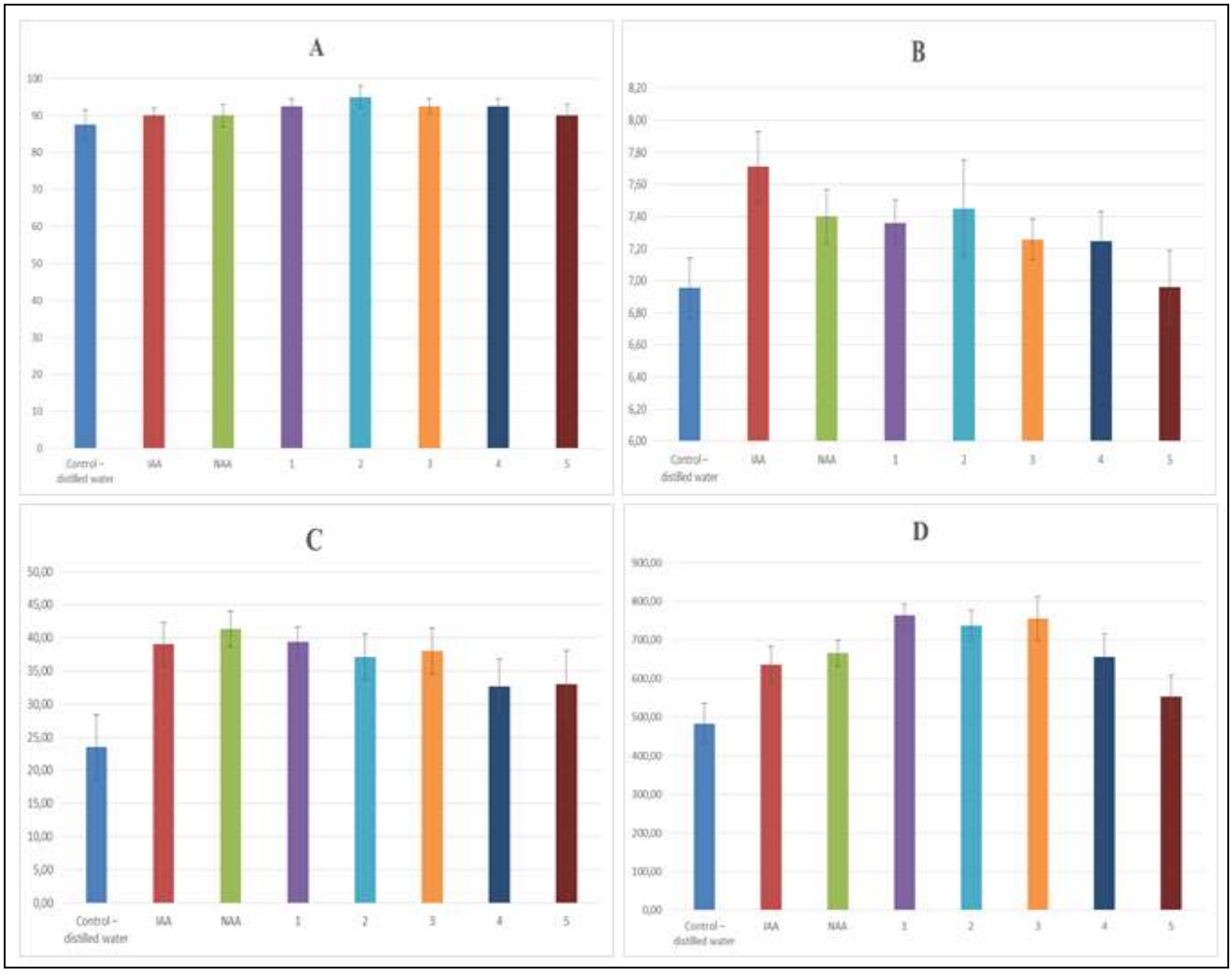


Figure 2: Stimulating effect of auxins IAA (1*H*-Indol-3-ylacetic acid) and NAA (1-Naphthylacetic acid) and chemical heterocyclic compounds, derivatives of pyrimidine (compound №1 - 6-Methanesulfonyl-imidazo[1,2-*a*]pyrimidine-5-ylamine), pyrazole (compound №2 - 5-Hydrazino-1-phenyl-1*H*-pyrazole-4-carbohydrazide and compound №3 - 3-Ethyl-7-methyl-3,7-dihydro-4*H*-pyrazolo[3,4-*d*][1,2,3]triazin-4-one), isoflavones (compound №4 - 5-Hydroxy-7-methoxy-8-(methoxymethyl)-3-(4-methoxyphenyl)-4*H*-chromen-4-one), pyridine (compound №5 – ((1*H*-pyrrolo[2,3-*c*]pyridin-3-yl)-acetic acid) on biometric indices of the 15th-day-old flax seedlings cultivar Ukrainian 3. A – number of germinated seeds (%), B – length of shoots (cm), C – total number of roots (pcs), D – total length of roots (mm). Control - flax seedlings grown on the distilled water

Particularly it was found that the biometric indices of flax seedlings grown on 10^{-8}M water solution of compound №1 - 6-Methanesulfonyl-imidazo[1,2-*a*]pyrimidine-5-ylamine were higher of the biometric indices of flax seedlings grown either on distilled water (control) or on 10^{-8}M water solution of auxins IAA and NAA

in average: according with length of shoots – at the 6 % as compared with control; according with total length of roots – at the 58 %, 20 %, and 15 % as compared with control, IAA and NAA, respectively; according with total number of roots – at the 67 % as compared with control (Figure 2).

The biometric indices of flax seedlings grown on 10^{-8}M water solution of compound №2 – 5-Hydrazino-1-phenyl-1*H*-pyrazole-4-carbohydrazide, were higher of the biometric indices of flax seedlings grown either on distilled water (control) or on 10^{-8}M water solution of auxins IAA and NAA in average: according with length of shoots – at the 7 % as compared with control; according with total length of roots – at the 53 %, 16 %, and 11 % as compared with control, IAA and NAA, respectively; according with total number of roots – at the 58 % as compared with control (Figure 2).

The biometric indices of flax seedlings grown on 10^{-8}M water solution of compound №3 – 3-Ethyl-7-methyl-3,7-dihydro-4*H*-pyrazolo[3,4-*d*][1,2,3]triazin-4-one, were higher of the biometric indices of flax seedlings grown either on the distilled water (control) or on 10^{-8}M water solution of auxins IAA and NAA in average: according with length of shoots – at the 5 % as compared with control; according with total length of roots – at the 56 %, 19 %, and 13 % as compared with control, IAA and NAA, respectively; according with total number of roots – at the 61 % as compared with control (Figure 2).

The biometric indices of flax seedlings grown on 10^{-8}M water solution of compound №4 – 5-Hydroxy-7-methoxy-8-(methoxymethyl)-3-(4-methoxyphenyl)-4*H*-chromen-4-one, were higher of the biometric indices of flax seedlings grown either on the distilled water (control) or on 10^{-8}M water solution of auxins IAA and NAA in average: according with length of shoots – at the 5 % as compared with control; according with total length of roots – at the 36 % and 3 % as compared with control and IAA, respectively; according with total number of roots – at the 39 % as compared with control (Figure 2).

The biometric indices of flax seedlings grown on 10^{-8}M water solution of compound №5 – ((1*H*-pyrrolo[2,3-*c*]pyridin-3-yl)-acetic acid), were higher than the biometric indices of flax seedlings grown either on the distilled water (control) or on 10^{-8}M water solution of auxins IAA and NAA in average: according with total length of roots – at the 15 % as compared with control; according with total number of roots – at the 40 % as compared with control (Figure 2).

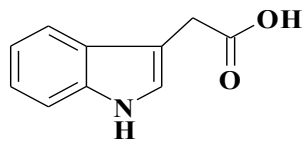
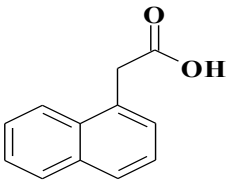
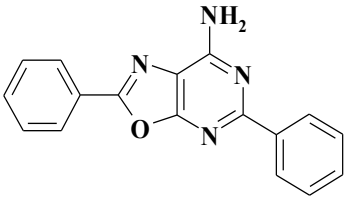
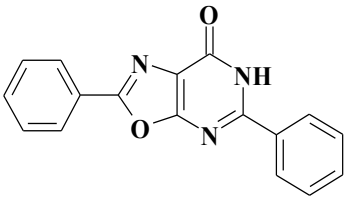
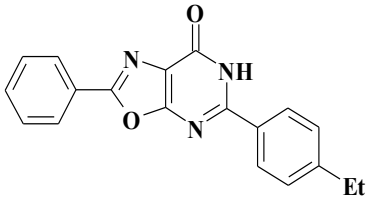
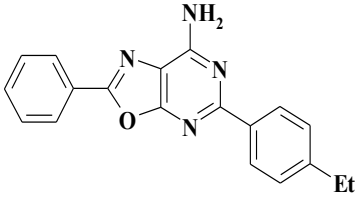
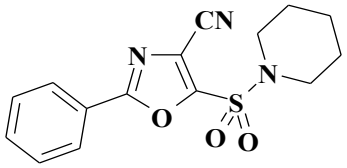
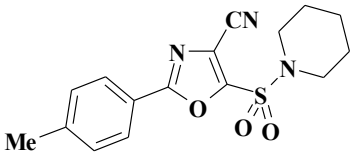
Thus, the obtained results testified that all tested chemical heterocyclic compounds derivatives of pyrimidine, pyrazole, isoflavones and pyridine showed auxin-like stimulating effect on growth of shoot and root systems of the 15^{th}-day-old seedlings of flax (*Linum usitatissimum* L.) cultivar Ukrainian 3. Obviously, that auxin-like growth stimulating effect of the chemical heterocyclic compounds is explained by their inducing action on plant cell elongation, proliferation and differentiation that are the basic processes of plant growth and development[48-53].

3.2. Study of stimulating effect of derivatives of oxazolopyrimidine and oxazole on growth of flax (*Linum usitatissimum* L.) cultivar Svitanok

The comparative analysis of stimulating effect of plant hormones auxins IAA and NAA, and chemical heterocyclic compounds, derivatives of oxazolopyrimidine and oxazole on growth of the flax (*Linum usitatissimum* L.) seedlings cultivar Svitanok was conducted.

The chemical structure, chemical name and molecular mass (MM) of plant hormones auxins IAA (1*H*-Indol-3-ylacetic acid) and NAA (1-Naphthylacetic acid), and tested chemical heterocyclic compounds, derivatives of oxazolopyrimidine (compounds № 1-4) and oxazole (compounds № 5 and 6) are shown in the Table 2.

Table 2: Chemical structure of plant hormones and chemical heterocyclic compounds, derivatives of oxazolopyrimidine and oxazole

№	Chemical structure of compounds	Chemical name and relative molecular mass of compounds
IAA		IAA (1*H*-Indol-3-ylacetic acid), MM 175.19
NAA		NAA (1-Naphthylacetic acid), MM 186.21
1		7-Amino-2,5-diphenyl[1,3]oxazolo[5,4-*d*]pyrimidine, MM 288.31
2		2,5-Diphenyl[1,3]oxazolo[5,4-*d*]pyrimidin-7(6*H*)-one, MM 289.30
3		5-(4-Ethylphenyl)-2-phenyl[1,3]oxazolo[5,4-*d*] pyrimidin-7(6*H*)-one, MM 317.35
4		7-Amino-5-(4-ethylphenyl)-2-phenyl[1,3]oxazolo[5,4-*d*]pyrimidine, MM 316.37
5		2-Phenyl-5-(piperidin-1-ylsulfonyl)-1,3-oxazole-4-carbonitrile, MM 317.37
6		2-Tolyl-5-(piperidin-1-ylsulfonyl)-1,3-oxazole-4-carbonitrile, MM 331.40

It was found that chemical heterocyclic compounds used at the concentration 10^{-9}M showed auxin-like stimulating effect on growth and development of shoot and root system of the flax seedlings during 20 days (Figure 3).

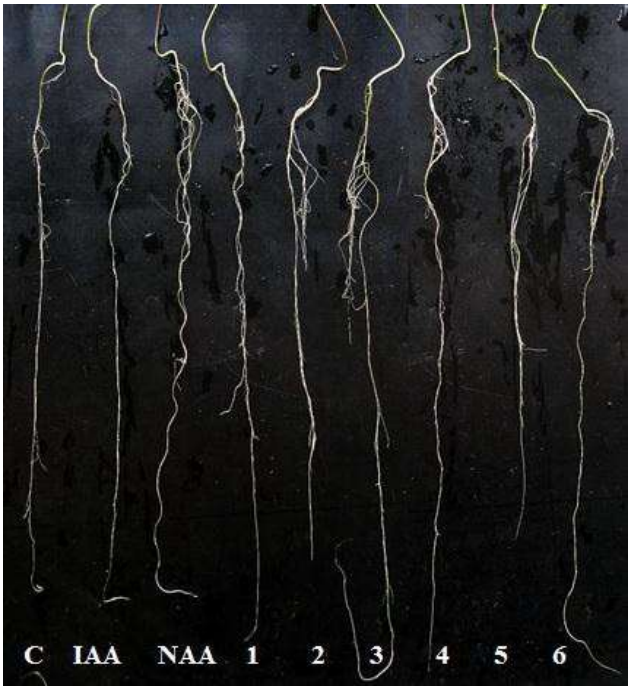


Figure 3: Stimulating effect of auxins IAA (1*H*-Indol-3-ylacetic acid) and NAA (1-Naphthylacetic acid), and chemical heterocyclic compounds, derivatives of oxazolopyrimidine (compound №1 - 7-amino-2,5-diphenyl[1,3]oxazolo[5,4-*d*]pyrimidine, compound №2 - 2,5-diphenyl[1,3]oxazolo[5,4-*d*]pyrimidin-7(6*H*)-one, compound №3 - 5-(4-ethylphenyl)-2-phenyl[1,3]oxazolo[5,4-*d*]pyrimidin-7(6*H*)-one, compound №4 - 7-amino-5-(4-ethylphenyl)-2-phenyl[1,3]oxazolo[5,4-*d*]pyrimidine) and oxazole (compound №5 - 2-phenyl-5-(piperidin-1-ylsulfonyl)-1,3-oxazole-4-carbonitrile and compound №6 - 2-tolyl-5-(piperidin-1-ylsulfonyl)-1,3-oxazole-4-carbonitrile) on growth of root system of the 20th-day-old flax seedlings cultivar Svitanok as compared to control (C) flax seedlings grown on the distilled water

The comparative analysis of the biometric indices (i.e. number of germinated seeds (%), length of shoots (cm), total number of roots (pcs), total length of roots (mm)) showed that the biometric indices of 20th-day-old flax seedlings cultivar Svitanok grown on water solution of heterocyclic compounds, derivatives of oxazolopyrimidine and oxazole used at the concentration 10^{-9}M were higher of the biometric indices of flax seedlings grown on water solution of auxins IAA and NAA used at the same concentration 10^{-9}M and control flax seedlings grown on distilled water in average: according with length of shoots – at the 11-14 %, 13-16 % and 21-24 % as compared with control, IAA, and NAA, respectively; according with total length of roots – at the 24-80 %, 15-35 %, and 10-68 % as compared with control, IAA, and NAA, respectively; according with total number of roots – at the 28-79 %, 14-27 %, and 5-12 % as compared with control, IAA, and NAA, respectively (Figure 4).

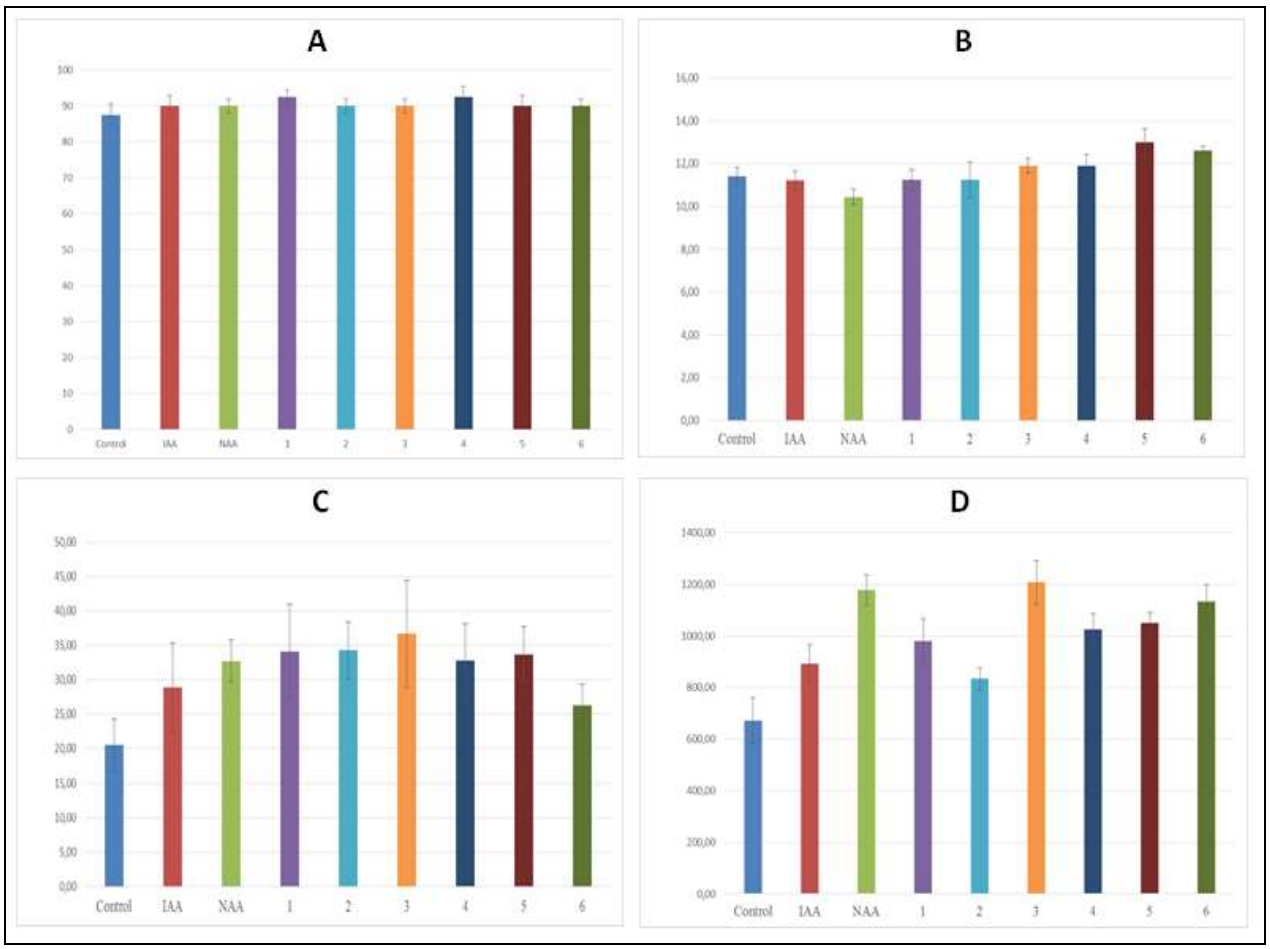


Figure 4: Stimulating effect of auxins IAA (1*H*-Indol-3-ylacetic acid) and NAA (1-Naphthylacetic acid) and chemical heterocyclic compounds, derivatives of oxazolopyrimidine (compound №1 - 7-amino-2,5-diphenyl[1,3]oxazolo[5,4-*d*]pyrimidine, compound №2 - 2,5-diphenyl[1,3]oxazolo[5,4-*d*]pyrimidin-7(6*H*)-one, compound №3 - 5-(4-ethylphenyl)-2-phenyl[1,3]oxazolo[5,4-*d*]pyrimidin-7(6*H*)-one, compound №4 - 7-amino-5-(4-ethylphenyl)-2-phenyl[1,3]oxazolo[5,4-*d*]pyrimidine) and oxazole (compound №5 - 2-phenyl-5-(piperidin-1-ylsulfonyl)-1,3-oxazole-4-carbonitrile and compound №6 - 2-tolyl-5-(piperidin-1-ylsulfonyl)-1,3-oxazole-4-carbonitrile) on biometric indices of the 20th-day-old flax seedlings cultivar Svitanok. A – number of germinated seeds (%), B – length of shoots (cm), C – total number of roots (pcs), D – total length of roots (mm), Control - flax seedlings grown on the distilled water

Particularly it was found that the biometric indices of flax seedlings grown on 10^{-9}M water solution of compound №1 - 7-amino-2,5-diphenyl[1,3]oxazolo[5,4-*d*]pyrimidine were higher of the biometric indices of flax seedlings grown either on distilled water (control) or on 10^{-9}M water solution of auxins IAA and NAA in average: according with total length of shoots – at the 46 %, 10 % as compared with control and IAA, respectively; according with total number of roots – at the 66 %, 18 % and 4 % as compared with control, IAA and NAA, respectively (Figure 4).

The biometric indices of flax seedlings grown on 10^{-9}M water solution of compound №2 - 2,5-diphenyl[1,3]oxazolo[5,4-*d*]pyrimidin-7(6*H*)-one were higher of the biometric indices of flax seedlings grown either on the distilled water (control) or on 10^{-9}M water solution of auxins IAA and NAA in average: according with total length of roots – at the 24 % as compared with control; according with total number of roots – at the 66 %, 18 % and 4 % as compared with control, IAA and NAA, respectively (Figure 4).

The biometric indices of flax seedlings grown on 10^{-9}M water solution of compound №3 - 5-(4-ethylphenyl)-2-phenyl[1,3]oxazolo[5,4-*d*]pyrimidin-7(6*H*)-one were higher of the biometric indices of flax

seedlings grown either on distilled water (control) or on 10^{-9}M water solution of auxins IAA and NAA in average: according with total length of roots – at the 80 %, 35 % and 3% as compared with control, IAA and NAA, respectively; according with total number of roots – at the 79 %, 27 % and 12 % as compared with control, IAA and NAA, respectively (Figure 4).

The biometric indices of flax seedlings grown on 10^{-9}M water solution of compound №4 - 7-amino-5-(4-ethylphenyl)-2-phenyl[1,3]oxazolo[5,4-*d*]pyrimidine were higher of the biometric indices of flax seedlings grown either on distilled water (control) or on 10^{-9}M water solution of auxins IAA and NAA in average: according with total length of roots – at the 53 % and 15 % as compared with control and IAA, respectively; according with total number of roots – at the 60 % and 14 % as compared with control and IAA, respectively (Figure 4).

The biometric indices of flax seedlings grown on 10^{-9}M water solution of compound №5 - 2-phenyl-5-(piperidin-1-ylsulfonyl)-1,3-oxazole-4-carbonitrile were higher of the biometric indices of flax seedlings grown either on distilled water (control) or on 10^{-9}M water solution of auxins IAA and NAA in average: according with length of shoots – at the 14 %, 16 % and 24 % as compared with control, IAA and NAA, respectively; according with total length of roots – at the 56 % and 18 % as compared with control and IAA, respectively; according with total number of roots – at the 64 % and 17 % as compared with control and IAA, respectively (Figure 4).

The biometric indices of flax seedlings grown on 10^{-9}M water solution of the compound №6 - 2-tolyl-5-(piperidin-1-ylsulfonyl)-1,3-oxazole-4-carbonitrile) were higher of the biometric indices of flax seedlings grown either on distilled water (control) or on 10^{-9}M water solution of the auxins IAA and NAA in average: according with length of shoots – at the 11 %, 13 % and 21 % as compared with control, IAA and NAA, respectively; according with total length of roots – at the 68 % and 27 % as compared with control and IAA, respectively; according with total number of roots – at the 28 % as compared with control (Figure 4).

It was found that the growth stimulating effect of all tested heterocyclic compounds depended on the various substituents in the chemical structure of heterocyclic compounds. The highest effect revealed the compound №3 - 5-(4-ethylphenyl)-2-phenyl[1,3]oxazolo[5,4-*d*]pyrimidin-7(6*H*)-one containing 4-ethylphenyl substituent at the 5th position and oxygen at the 7th position of pyrimidine fragment and the compound №5 - 2-phenyl-5-(piperidin-1-ylsulfonyl)-1,3-oxazole-4-carbonitrile containing phenyl substituent at the 2th position of oxazole.

At the same time the lower growth stimulating effect revealed the compounds: the compound №1 - 7-amino-2,5-diphenyl[1,3]oxazolo[5,4-*d*]pyrimidine containing amino group at the 7th position of pyrimidine fragment, the compound №2 - 2,5-diphenyl[1,3]oxazolo[5,4-*d*]pyrimidin-7(*6H*)-one containing phenyl substituent at the 5th position of pyrimidine fragment, the compound №4 - 7-amino-5-(4-ethylphenyl)-2-phenyl[1,3]oxazolo[5,4-*d*]pyrimidine containing amino group at the 7th position of pyrimidine fragment, and the compound №6 - 2-tolyl-5-(piperidin-1-ylsulfonyl)-1,3-oxazole-4-carbonitrile containing tolyl substituent at the 2th position of oxazole.

Possibly, that growth stimulating effect of the tested heterocyclic compounds depended on the presence of various substituents at the 5th and 7th positions of pyrimidine fragment in the derivatives of oxazolopyrimidine (compounds №1-4) and different substituents at the 2th position of oxazole in the derivatives of oxazole (compounds №5 and №6).

4. Conclusion

The stimulating effect of low molecular weight heterocyclic compounds, derivatives of pyrimidine, pyrazole, isoflavones, pyridine, oxazolopyrimidine and oxazole on acceleration of vegetative growth of flax (*Linum usitatissimum* L.) two cultivars Ukrainian 3 and Svitanok was studied. It was shown that all classes of chemical heterocyclic compounds demonstrated auxin-like growth stimulating effect, which was similar or higher of the effect of plant hormones IAA and NAA. The biometric indices of 15th-day-old flax seedlings cultivar Ukrainian 3 grown on water solution of heterocyclic compounds, derivatives of pyrimidine, pyrazole, isoflavones and pyridine used at the concentration 10^{-8}M were higher of the biometric indices of flax seedlings

grown on water solution of auxins IAA and NAA used at the same concentration 10^{-8}M and control flax seedlings grown on distilled water in average: according with length of shoots – at the 5-7 % as compared with control; according with total length of roots – at the 15–58 %, 3-20 %, 11–15 % as compared with control, IAA, and NAA, respectively; according with total number of roots – at the 39–67 % as compared with control. The biometric indices of 20th-day-old flax seedlings cultivar Svitanok grown on water solution of heterocyclic compounds, derivatives of oxazolopyrimidine and oxazole used at the concentration 10^{-9}M were higher of the biometric indices of flax seedlings grown on water solution of auxins IAA and NAA used at the same concentration 10^{-9}M and control flax seedlings grown on distilled water in average: according with length of shoots – at the 11-14 %, 13-16 % and 21-24 % as compared with control, IAA, and NAA, respectively; according with total length of roots – at the 24-80 %, 15-35 %, and 10-68 % as compared with control, IAA, and NAA, respectively; according with total number of roots – at the 28-79 %, 14-27 %, and 5-12 % as compared with control, IAA, and NAA, respectively. The growth stimulating effect of chemical heterocyclic compounds depended on the various substituents in the chemical structure of heterocyclic compounds. The obtained results confirmed the perspective of practical application of derivatives of pyrimidine, pyrazole, isoflavones, pyridine, oxazolopyrimidine and oxazole for acceleration of growth and development of flax (*Linum usitatissimum* L.) cultivars Ukrainian 3 and Svitanok during vegetative stage.

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