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SEED PRODUCTIVITY OF ALFALFA VARIETIES DEPENDING ON THE CONDITIONS OF HUMIDIFICATION AND GROWTH REGULATORS IN THE SOUTHERN STEPPE OF UKRAINE

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Abstract

The aim of the study was to determine the effect of humidification conditions (drip irrigation and no irrigation) and growth regulators (Agrostimulin, Garth, Lucis, Emistim C) on the seed productivity of alfalfa varieties Unitro and Zoryana. The study was carried out during 2012-2015 at the experimental field of the Institute of Irrigated Agriculture of NAAS on the dark-chestnut soil in the conditions of the Steppe zone. The yield of alfalfa seeds in the conditions of natural humidification was (by the years of life) 154; 471; 235 kg/ha, and drip irrigation increased them to 207; 640; 538 kg/ha. Application of the growth regulators favored for the increase in the seed yield: 161-171; 479-492; 245-256 kg/ha without irrigation, and 217-230; 653-668; 559-583 kg/ha at drip irrigation. The highest yield of 175; 497; 261 kg/ha and 236; 674; 594 kg/ha was obtained in the variants with Garth growth regulator application. Drip irrigation increased the root mass from 1.61 to 2.03 t/ha. The preparations stimulated the root mass accumulation, mostly at drip irrigation, by the years of the crop life: Agrostimulin – 2.46; 5.36; 6.78 t/ha, Lucis – 2.50; 5.61; 7.05, Emistim C – 2.42; 5.28; 6.72 and Garth with the maximum indices – 2.53; 5.73; 7.25 t/ha. Atmospheric nitrogen fixation increased from the first to the second year of the crop life, and further decreased to the third year of the herbage life. Strong correlation ties between the seed productivity and root mass accumulation (r= 0.932-0.984), atmospheric nitrogen fixation (r= 0.960-0.975) and between the root mass accumulation and atmospheric nitrogen fixation (r= 0.990-0.996) were determined.

Key words**:** *alfalfa, variety, seed productivity, root mass, atmospheric nitrogen fixation, natural humidification, drip irrigation, growth regulators*

INTRODUCTION

Alfalfa is the most wide-spread forage crop in the world. The crop is posed as one for solving the problem of plant protein in the forage for cattle. However, the practical value of alfalfa is not limited to its fodder qualities. It also performs other important functions: agrotechnical, biological, agroecological. Alfalfa enriches the soil with nitrogen, accumulates a large amount of post-harvest residues, root mass, improves soil structure, reduces the effects of water and wind erosion, is a good fore-crop for many crops. The lack of sufficient seed material, due to low seed yield, does not allow to expand the sown areas of this valuable crop. Therefore, appropriate technologies are needed, the main elements of which would contribute to the normal growth and development of plants.

The most efficient factors of the influence on the yield of alfalfa seeds are irrigation (drip, sprinkling, surface) and the use of growth regulators [2, 36]. The advantages of drip irrigation over conventional irrigation methods are well known for a long time, and due to high economic efficiency and environmental safety, it is widely used in irrigation of crops. Drip irrigation helps to increase crop yields due to strict control and maintenance of optimal soil moisture throughout the growing season while reducing irrigation rates and reducing the cost of irrigation water per unit of yield. Studies have shown that the production of alfalfa seeds at drip irrigation required half less irrigation water [17], while the seed yield was by 20-25% higher than at conventional methods of irrigation [26]. But the main advantage of drip irrigation use on the seed crops is the possibility of more precise control of soil moisture at the necessary interphase periods.

At the same time, higher doses of mineral fertilizers are used to increase yields, but they lead to environmental pollution and, in the end - to the deterioration of plant products quality. Taking into account significant increase in the cost of basic resources, depletion of natural resources, it is necessary to reduce the use of mineral fertilizers and at the same time increase the use of microbiological preparations, plant growth regulators, micronutrients [4, 27]. In the conditions of climate change, with increasing food shortages, it is necessary to ensure sustainable agricultural production, the support of which is possible with the widespread use of biostimulants. Therefore, in most developed countries, biological methods of agriculture are intensively developed and mastered , based on the reduction or abandonment of synthetic fertilizers and chemical plant protection products with maximum use of biological factors of the increase in soil fertility, disease, pest and weed control, and implementation of a set of other measures that do not have an adverse effect on the environment, but improve the conditions of crop formation [3, 27]. For example, according to the European Council of the Biostimulator Industry (EBIC), more than 6.2 million hectares were treated with biostimulants in Europe in 2012, with an overall annual growth rate of 12.5% between 2013 and 2018 [5, 7], and by 2026 the market of biostimulants is estimated to be about 5 billion US dollars.

The use of plant growth regulators is an efficient element of energy-saving agricultural technologies, which contributes to the creation of appropriate conditions for growth and development of plants of different crops and is an important reserve for the improvement in productivity and quality of agricultural products for human health insurance, animals, useful fauna of agrocenoses safety, are the most economical and do not require additional material resources [1, 9, 12, 32, 35].

In its turn, growth regulators have a positive effect on plant life processes, stimulate seed germination, photosynthesis, transport of substances, formation processes, resistance to abiotic stresses (lack of moisture, high and low temperatures) [10,20,23,29]. Today, their application is one of the important and prospective areas of management of the production process of crops that regulate the growth and development of plants [15]. Biostimulants increase the resistance of crops to adverse weather conditions and to their damage by pests and diseases. In general, under their influence, the genetic potential of plants created by nature and breeding work is more fully opened, and at the same time they play as important role as the use of mineral fertilizers [21]. The high efficiency of these preparations is due to the content of a balanced complex of biologically active substances, which accelerates the growth of vegetative mass and root system, and therefore more intensive use of nutrients, increase the resistance of plants to diseases, stresses and adverse weather conditions. This allows to reduce the use of pesticides by 20-30% without reducing the protective effect [34].

Analysis of the literature showed that in the nearest future stimulants will be no less important in agricultural production than mineral fertilizers. In this regard, the search for new forms of effective growth regulators and optimal ways of their use is a relevant problem in the crop’s cultivation technology, and alfalfa for seed purposes is not an exception.

The aim of the study was to identify the effect of different growth regulators on seed productivity of alfalfa varieties, root mass accumulation and fixation of atmospheric nitrogen under different conditions of humidification.

MATERIALS AND METHODS

The study was conducted during 2012-2015 at the research field of the Institute of Irrigated Agriculture of NAAS. In terms of soil and climate, it is in the Steppe zone (Kherson oblast, the South of Ukraine), around the Ingulets irrigated array.

The field experiment was carried out by the method of split plots. The main areas (factor A) – humidification conditions (without irrigation and drip irrigation); sub-plots (factor B) – alfalfa varieties (Unitro and Zoryana); sub-subplots (factor C) – foliar treatment in the interphase period "beginning of flowering – massive flowering" with growth regulators: 1 – control 1 (without treatment); 2 – control 2 (water treatment); 3 – Agrostimulin; 4 – Garth; 5 – Lucis and 6 – Emistim C. The crop was sown in the early spring by the wide-row method with a row spacing of 70 cm. The area of a sowing plot – 60 m^2, accounting – 50 m^2. The study was conducted in four replications.

Agrostimulin is a plant growth regulator. The preparation is represented by a balanced composition of a complex of growth substances of natural origin (extract of endophytic mycorrhizal fungi) and a synthetic analogue of phytohormones – 2,6-dimethylpyridine-1-oxide (N-oxide-dimethylpyridine – Ivin), 26 g/L + Emistim C – 1 g/L. The preparation combines the physiological activity of its components – auxin activity of Ivin and cytokinin activity of Emistim C. It is a transparent colorless aqueous-alcoholic solution [11].

Garth is a plant growth regulator, aqueous solution of a mixture of preparations Triman (a crystalline powder of light pink or gray color ($C_6H_6NOMnCl_2$ – aqua-N-oxide-2-methylpyridine manganese (II) chloride) – 500 g/L) and Tetran (white crystalline powder ($C_{12}H_{14}N_2O_2ZnCl_2$ – bis-N-oxide-2-methylpyridine zinc (II) chloride) – 500 g/L) in the ratio of components 1:1.

Lucis is a plant growth regulator. The preparation is a white crystalline powder. Active substance: 2,6 dimethylpyridine-1-oxide with succinic acid, 990 g/kg and ammonium molybdate, 1.0 g/kg. It is recommended for application on alfalfa and clover.

Emistim C is a highly efficient plant growth regulator of natural origin with a wide range of action – a product of biotechnological cultivation of fungi-epiphytes from the root system of sea buckthorn and ginseng, obtained on the basis of metabolites of endomycorrhizal fungi. It contains a balanced set of regulators of auxin, cytokinin nature and amino acids, carbohydrates, fatty acids, microelements [11].

Treatment with growth regulators was carried out with a knapsack sprayer in the phase of plant development "beginning of flowering": Agrostimulin and Emistim C at a rate of 10 ml/ha, Garth – 50 ml/ha and Lucis – 10 g/ha.

Watering was carried out by drip irrigation with the laying of drip tape in each row. The estimated root-containing layer of soil was taken according to the interphase periods: "seedling-stalking" – 0.3 m, "stalking-budding" – 0.5 m, "budding-ripening of seeds" – 0.7 m. Soil moisture in the interphase period "seedlings-beginning of flowering" was maintained at 70-75% FC (field capacity) and from the interphase period "beginning of flowering-ripening of seeds" we reduced it to 50-55% FC.

The study of root distribution was performed by the method of washing, which allowed to determine their weight and percentage distribution (after harvesting) by the soil layers for every 10 cm [30]. Nitrogen fixation was determined by the balance method [22].

Statistical processing of yield data was performed by the method of analysis of variance according to V.O. Ushkarenko et al. [33].

RESULTS AND DISCUSSIONS

The obtained experimental data by the years of life indicate a different reaction of alfalfa varieties on the seed productivity to the studied factors: humidification and growth stimulants. It should be mentioned that the seed yield is maximized from the first year of the herbage life to the second, and it remains high in the third, regardless of humidification conditions. So, in particular at irrigation, seed productivity by Unitro and Zoryana varieties averaged to 203 and 212 kg/ha (1st year), 643; 649 (2nd year), 555; 559 kg/ha (3rd year) against the variant without irrigation, respectively, 152; 158; 463; 473; 239 and 243 kg/ha (Table 1).

Table 1. Alfalfa seed yield by the years of life depending on irrigation, variety, and application of growth regulators (average for 2012-2015)

Humidification conditions (factor A)	Variety (factor B)	Application of plant growth regulators (factor C)	Years of life		
			first	second	third
No irrigation	Unitro	control 1 (no treatment)	145	451	227
		control 2 (water treatment)	146	452	229
		Agrostimulin	149	460	236
		Garth	162	477	251
		Lucis	158	472	247
		Emistim C	154	465	242
		Average	**152**	**463**	**239**
	Zoryana	control 1 (no treatment)	154	471	235
		control 2 (water treatment)	154	471	235
		Agrostimulin	161	479	245
		Garth	175	497	261
		Lucis	171	492	256
		Emistim C	166	485	251
		Average	164	483	247
	Average		**158**	**473**	**243**
Drip irrigation	Unitro	control 1 (no treatment)	191	628	530
		control 2 (water treatment)	193	628	531
		Agrostimulin	200	641	549
		Garth	217	661	584
		Lucis	212	655	573
		Emistim C	207	645	562
		Average	**203**	**643**	**555**
	Zoryana	control 1 (no treatment)	207	640	538
		control 2 (water treatment)	208	641	538
		Agrostimulin	217	653	559
		Garth	236	674	594
		Lucis	230	668	583
		Emistim C	224	658	572
		Average	220	656	564
	Average		**212**	**649**	**559**
Partial differences estimation					
LSD_{05}		A	22.9	22.5	27.5
LSD_{05}		B	3.6	4.0	1.6
LSD_{05}		C	2.5	2.2	3.2
Main effects differences estimation					
LSD_{05}		A	7.3	7.1	8.7
LSD_{05}		B	1.1	1.3	0.5
LSD_{05}		C	1.2	1.1	1.6

Source: Own study.

Analysis of the data shows that a significant impact on seed yields is made by irrigation and the application of growth stimulants that improve the plants growth and development, which generally has a positive effect on the formation of their generative bodies and, consequently, seed yield. Treatment of crops with growth regulators Agrostimulin, Lucis, Emistim C increased the yield of alfalfa seeds, compared to the control, by 1.2-11.7% (without irrigation) and by 2.1-13.6% (with irrigation) in the varieties Unitro, and 1.6-13.6% and 2.0-14.0% ─ in the variety Zoryana, respectively.

This is confirmed by the studies with the application of stimulants Agrostimulin and

Emistim C on other crops, which increased the yield of peas by 5.4-11.0%, soybeans - by 7.0-11.0, winter wheat - by 15.0-20.0%, clover seeds, alfalfa up to 23.0% [6,16,19]. Having used the preparation Garth a positive effect was also recorded, the increase in yield of spring wheat grain was 0.53 t/ha, of corn - 0.77 t/ha, of soybeans – 0.58 t/ha. In our studies, the highest efficiency was determined at the use of the preparation Garth, for three years of the herbage life, regardless on humidification conditions. This ensured the highest yield of alfalfa seeds in the conditions of natural humidification - 162; 175 and 477; 497 and 251; 261 kg/ha against the yield on the control, respectively, 146; 452; 229 and 154; 471; 235 kg/ha. Drip irrigation and treatment of alfalfa herbage with this growth regulator provided the maximum seed productivity for Unitro and Zoryana varieties: 217; 236 and 661; 674 and 584; 594 kg/ha, respectively, at the yield on the control: 193; 208 and 628; 641; 584 and 594 kg/ha. It is noteworthy that in the conditions of natural humidification, the tested stimulants provided a significant increase in the seed yield compared to the control. This indicates an important aspect of their action, namely, enhancement of the crop resistance to adverse environmental factors, lack of moisture. Further, we have analysed the relationships between alfalfa seed productivity and root mass accumulation and nitrogen fixation, taking into account the importance of alfalfa as a fore-crop. Moreover, it is referred that there is a strong relationship between green mass productivity and root mass in alfalfa and other crops [14,24,28]. Our study has shown that there are close links between the seed yield and root mass accumulation and nitrogen fixation. In particular, the correlation coefficient between the seed yield and root mass accumulation in the conditions of natural humidification in Unitro variety was r = 0.973, and in Zoryana variety r = 0.958, at drip irrigation the correlation coefficients were higher in Unitro variety – r = 0.984 than in Zoryana variety – r = 0.932 (Fig. 1).

The amount of accumulated root mass of the alfalfa varieties tended to increase from the first year of life to the second and third years of the crop life (Table 2).

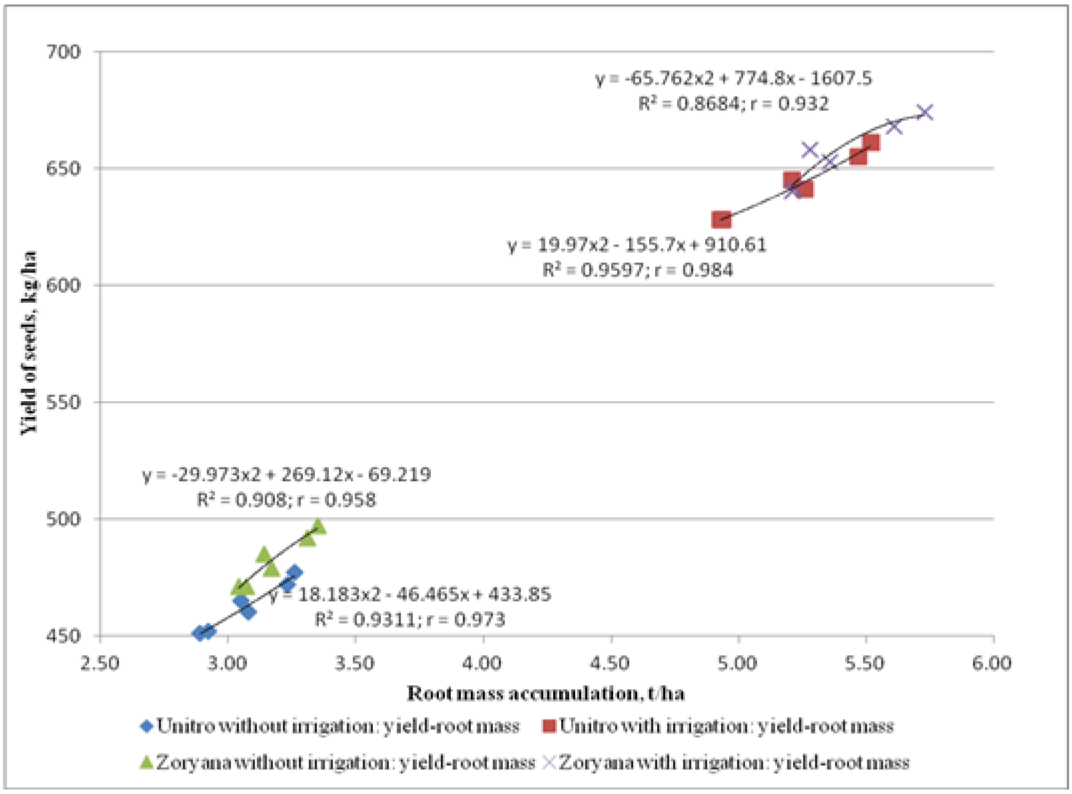

Fig. 1. Polynomial trend line of the dependence between the seed yield and root mass accumulation in the studied alfalfa varieties in the second year (average for 2012-2014)
Source: Own study.

Table 2. Accumulation of the air-dry alfalfa root mass by the years of life depending on irrigation, variety and application of growth regulators, t/ha (average for 2012-2015)

Humidification conditions (factor A)	Variety (factor B)	Application of plant growth regulators (factor C)	Years of life		
			first	second	third
Without irrigation	Unitro	control 1 (no treatment)	1.55	2.89	3.44
		control 2 (water treatment)	1.57	2.92	3.46
		Agrostimulin	1.88	3.08	3.57
		Garth	2.01	3.26	3.70
		Lucis	1.99	3.23	3.66
		Emistim C	1.82	3.05	3.53
		Average	1.80	3.07	3.56
	Zoryana	control 1 (no treatment)	1.61	3.04	3.50
		control 2 (water treatment)	1.62	3.07	3.51
		Agrostimulin	1.96	3.17	3.62
		Garth	2.01	3.35	3.76
		Lucis	1.99	3.31	3.71
		Emistim C	1.93	3.14	3.56
		Average	1.85	3.18	3.61
	Average		1,83	3.13	3.59
Drip irrigation	Unitro	control 1 (no treatment)	1.95	4.93	6.42
		control 2 (water treatment)	1.95	4.94	6.44
		Agrostimulin	2.33	5.26	6.75
		Garth	2.54	5.52	7.13
		Lucis	2.51	5.47	6.97
		Emistim C	2.27	5.21	6.61
		Average	2.26	5.22	6.72
	Zoryana	control 1 (no treatment)	2.03	5.21	6.55
		control 2 (water treatment)	2.04	5.22	6.56
		Agrostimulin	2.46	5.36	6.78
		Garth	2.53	5.73	7.25
		Lucis	2.50	5.61	7.05
		Emistim C	2.42	5.28	6.72
		Average	2.33	5.40	6.82
	Average		2,29	5.31	6.77
Partial differences estimation					
LSD_{05}		A	0.003	0.20	0.12
LSD_{05}		B	0.030	0.41	0.22
LSD_{05}		C	0.016	0.08	0.09
Main effects differences estimation					
LSD_{05}		A	0.001	0.06	0.04
LSD_{05}		B	0.009	0.13	0.07
LSD_{05}		C	0.008	0.04	0.05

Source: Own study.

Analyzing the obtained experimental data, it should be mentioned that the studied growing conditions and agricultural practices had a significant impact on the degree of development of the root system. Thus, in the conditions of natural moisture supply, the accumulation of root mass ranged within 1.55 and 1.61 t/ha, drip irrigation increased the trait to 1.95 and 2.03 t/ha in the varieties Unitro and Zoryana, respectively. Agrostimulin, Lucis, Emistim C and Garth had a stimulating effect on the root system mass. The most positive effect of growth regulators was obtained at drip irrigation. Their use contributed to the accumulation of the root mass over the years of life: Agrostimulin – 2.46; 5.36; 6.78 t/ha, Lucis – 2.50; 5.61; 7.05, Emistim C – 2.42; 5.28; 6.72 and Garth – 2.53; 5.73; and 7.25 t/ha in the variety Zoryana. As the above data testify, the use of the preparation Garth was particularly effective and ensured the maximum accumulation of the root mass. The same regulation is reported by Sheliuto et al., who recorded that the use of growth regulators increased up to 10% the size of root mass of legumes and root supply of plants [25].

Alfalfa, due to its biological property – nitrogen fixation, fixes nitrogen from the atmosphere and is an active storage of nitrogen in the soil with the increase in this process in the second year of life. According to Tikhonovich et al., the efficiency of symbiosis increases from the 1st to the 3rd year of alfalfa cultivation [31]. But its level depends on the variety, namely, on the varietal characteristics of the location and development of the root system of the plants, growing conditions. It is possible to create favourable conditions for symbiotic nitrogen fixation by influencing bean-rhizobia symbiosis with growth regulators [8,12,13]. Growth stimulating substances activate microbiological processes in the area of the root system, significantly affect the symbiosis, which is manifested in the participation of these substances in the inoculation process, the genesis of nodules, regulation of nitrogen fixation activity [18, 37].

Determination of the atmospheric nitrogen fixation showed that it also varies depending on growing conditions and years of the herbage life. Thus, its increase took place from the first to the second year of life. However, in the third year, the reaction in both varieties was different. So, without irrigation nitrogen fixation on the control from 131.94 kg/ha in the second year, decreased to 123.45 kg/ha in the third, in the conditions of drip irrigation there was a slight increase - from 193.86 to 200.84 kg/ha, respectively. The same was also observed with the use of growth stimulants (Table 3).

Table 3. Fixation of the atmospheric nitrogen depending on irrigation, application of growth regulators and alfalfa variety by the years of life (average for 2012-2015)

Humidification conditions (factor A)	Variety (factor B)	Application of plant growth regulators (factor C)	Years of life		
			first	second	third
Without irrigation	Unitro	control 1 (no treatment)	69.53	131.94	123.45
		control 2 (water treatment)	70.05	133.12	123.89
		Agrostimulin	76.81	139.20	133.07
		Garth	86.62	148.72	145.07
		Lucis	86.07	144.60	139.65
		Emistim C	75.06	136.94	130.15
		Average	77.36	139.09	134.28
	Zoryana	control 1 (no treatment)	76.75	138.31	128.43
		control 2 (water treatment)	78.14	139.27	129.04
		Agrostimulin	87.11	148.55	136.97
		Garth	95.06	161.72	155.78
		Lucis	92.98	156.99	148.08
		Emistim C	84.64	147.32	133.19
		Average	85.78	148.69	139.69
	Average		85,78	143.86	136.98
Drip irrigation	Unitro	control 1 (no treatment)	118.51	193.86	200.84
		control 2 (water treatment)	119.31	195.16	213.39
		Agrostimulin	139.54	206.04	213.81
		Garth	149.72	219.01	227.33
		Lucis	144.91	210.60	220.51
		Emistim C	141.12	202.32	211.43
		Average	135.52	204.50	214.70
	Zoryana	control 1 (no treatment)	122.46	200.40	208.21
		control 2 (water treatment)	122.96	200.97	208,96
		Agrostimulin	147.72	212.84	218.17
		Garth	154.43	222.54	232,25
		Lucis	149.83	217.79	226,23
		Emistim C	144.73	210.15	212,99
		Average	140.36	210.78	219,57
	Average		137,94	207.64	217.14
Partial differences estimation					
LSD_{05}	A		0.867	26.02	0.849
LSD_{05}	B		0.455	9.84	6.563
LSD_{05}	C		0.708	2.63	3.609
Main effects differences estimation					
LSD_{05}	A		0.274	8.23	0.268
LSD_{05}	B		0.144	3.11	2.076
LSD_{05}	C		0.354	1.31	1.804

Source: Own study.

Analysis of the data, presented in the Table 3, indicates a positive effect of the studied growth regulators on the rate of fixation of atmospheric nitrogen under different humidification conditions. The use of Agrostimulin, Lucis and Emistim C helps to increase the fixation of atmospheric nitrogen in comparison with the control. In particular, they accumulated atmospheric nitrogen: without irrigation, in the first year 76.81; 86.07; 75.06 kg/ha, in the second year – 139.2; 144.6; 136.94 kg/ha and in the third year – 133.07; 139.65; 130.15 kg/ha against 69.53; 131.94; 123.43 kg/ha at the control. At drip irrigation, this figure was sufficiently higher and averaged to 139.54 in the first year; 144.91; 141.12, in the second year – 206.04; 210.60; 202.32 and in the third year – 213.39; 220.51; 211.43 kg/ha, at the control – 118.51; 193.86; 13.98 kg/ha, respectively.

The highest efficiency was at the application of the preparation Garth. It provided the maximum fixation of atmospheric nitrogen: 95.06; 161.72; 155.78 kg/ha without irrigation and 149.72; 219.01; 227.33 kg/ha in the irrigation conditions.

The study has found out a strong relationship between the seed yield and nitrogen fixation, it was in the variety Unitro at irrigation – correlation coefficient r = 0.965 and without irrigation r = 0.960, and in the variety Zoryana – r = 0.975 and r = 0.975, respectively (Fig. 2).

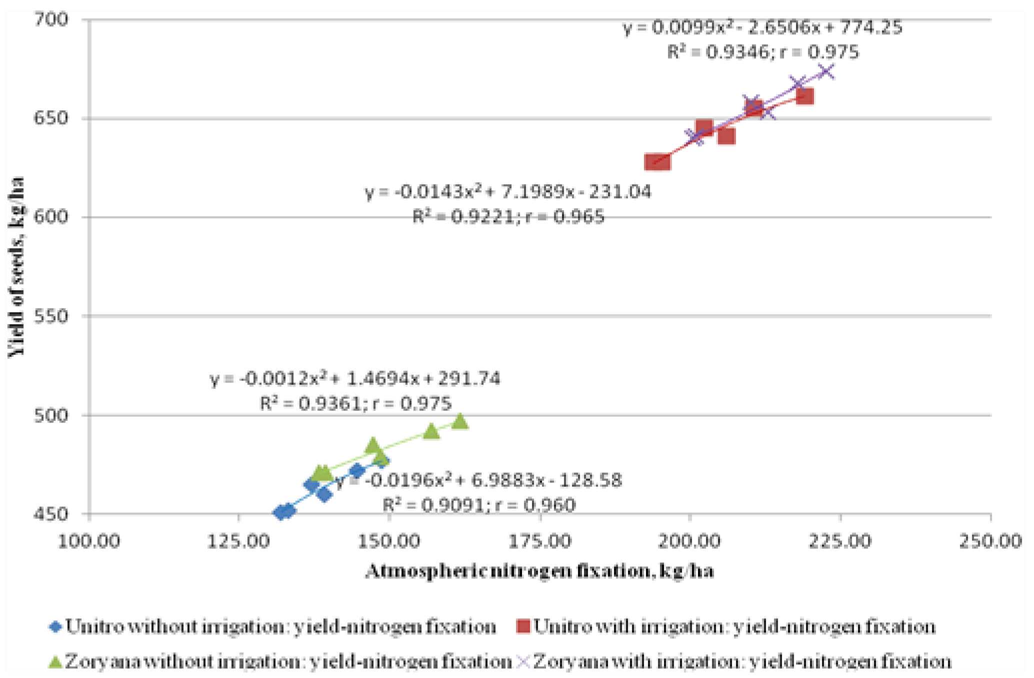

Fig. 2. Polynomial trend line of the dependence between the seed yield and atmospheric nitrogen fixation in the studied alfalfa varieties in the second year (average for 2012-2014)
Source: Own study.

At the increase in seed productivity of the plants, the root mass and nitrogen fixation of the varieties of alfalfa increases. However, the better developed the root system is, i.e. more in size, the stronger the nitrogen-fixing ability of the plants is, which is confirmed by the high correlation coefficient. Thus, under the conditions of natural humidification, the relationship between the accumulation of root mass and the fixation of atmospheric nitrogen in the cultivar Unitro was r = 0.985 and r = 0.993 in the cultivar Zoryana, and under drip irrigation r = 0.971 and r = 0.937, respectively (Fig. 3).

Economic efficiency estimation of the irrigation and growth stimulants application in the cultivation technology of seed alfalfa testifies that they payback (Table 4).

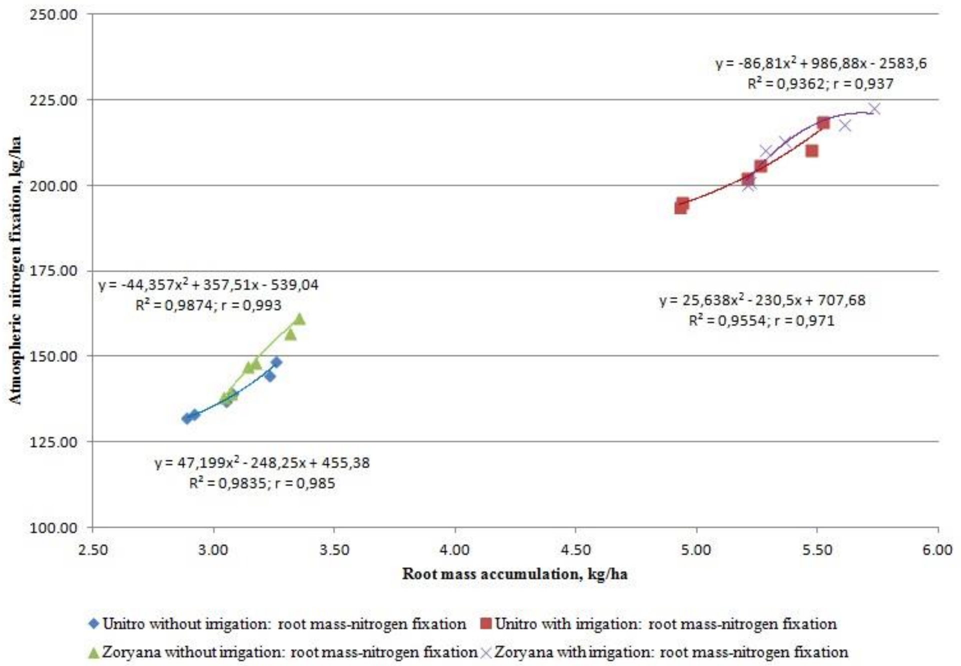

Fig. 3. Polynomial trend line of the dependence between the root mass accumulation and atmospheric nitrogen fixation in the studied alfalfa varieties in the second year (average for 2012-2014)
Source: Own study.

Table 4. Economic evaluation of alfalfa seed cultivation depending on humidification conditions and application of growth regulators (average for 2012-2015)

Variety (factor B)	Application of growth regulators (factor C)	Cost of seeds, EUR	Expenditures per 1 ha, EUR	Conditionally pure profit, EUR/ha	Prime cost of 1 kg of seeds, EUR	Profitability, %
Without irrigation (factor A)						
Unitro	control 1 (no treatment)	2,992.73	722.73	2,270.00	0.88	314.1
	control 2 (water treatment)	3,007.27	729.73	2,277.55	0.88	312.1
	Agrostimulin	3,072.73	737.27	2,335.45	0.87	316.8
	Garth	3,236.36	739.27	2,497.09	0.83	337.8
	Lucis	3,189.09	736.00	2,453.09	0.84	333.3
	Emistim C	3,130.91	738.73	2,392.18	0.86	323.8
	average	3,104.85	733.95	2,370.89	0.86	**323.0**
Zoryana	control 1 (no treatment)	3,127.27	722.73	2,404.55	0.84	332.7
	control 2 (water treatment)	3,127.27	729.73	2,397.55	0.85	328.6
	Agrostimulin	3,218.18	737.27	2,480.91	0.83	336.5
	Garth	3,392.73	739.27	2,653.45	0.79	358.9
	Lucis	3,341.82	736.00	2,605.82	0.80	354.1
	Emistim C	3,280.00	738.73	2,541.27	0.82	344.0
	average	3,247.88	733.95	2,513.92	0.82	**342.5**
Average		3,176.36	733.95	2,442.41	0.84	***332.8***
Drip irrigation (factor A)						
Unitro	control 1 (no treatment)	4,905.45	1,220.30	3,685.15	0.91	302.0
	control 2 (water treatment)	4,916.36	1,227.30	3,689.06	0.91	300.6
	Agrostimulin	5,054.55	1,234.85	3,819.70	0.89	309.3
	Garth	5,316.36	1,236.85	4,079.52	0.85	329.8
	Lucis	5,236.36	1,233.45	4,002.91	0.86	324.5
	Emistim C	5,141.82	1,236.30	3,905.52	0.88	315.9
	average	5,095.15	1,231.51	3,863.64	0.88	**313.7**
Zoryana	control 1 (no treatment)	5,036.36	1,220.30	3,816.06	0.88	312.7
	control 2 (water treatment)	5,043.64	1,227.30	3,816.33	0.88	311.0
	Agrostimulin	5,196.36	1,234.85	3,961.52	0.86	320.8
	Garth	5,469.09	1,236.85	4,232.24	0.82	342.2
	Lucis	5,385.45	1,233.45	4,152.00	0.83	336.6
	Emistim C	5,287.27	1,236.30	4,050.97	0.85	327.7
	average	5,236.36	1,231.51	4,004.85	0.86	**325.2**
Average		5,165.76	1,231.51	3,934.25	0.87	***319.5***

Source: Own study. Note: the cost of 1 kg of the alfalfa seeds was 3.64 EUR.

Over the years of the study in Unitro and Zoryana varieties of alfalfa, the cost of 1 kg of seeds under the cultivation in the conditions of natural humidification depended on the weather conditions of the year, and averaged to 0.86 EUR/kg and 0.82 EUR/kg, respectively. At drip irrigation, the cost of 1 kg of seeds for the variety Unitro was 0.88 EUR/kg and for Zoryana ─ 0.86 EUR/kg. The use of growth regulators, regardless the conditions of humidification, reduced the cost of 1 kg of seeds.

The highest pure profit was obtained in the variety Zoryana at drip irrigation and application of the growth regulator Garth ─ 4,232.24 EUR/ha, while in the variety Unitro this figure was lower and averaged to 4,079.51 EUR/ha. Under the conditions of natural humidification, the highest pure profit from the cultivation of Unitro and Zoryana varieties was also obtained under the application of the growth regulator Garth ─ 2,497.09 and 2,653.45 EUR/ha, respectively.

CONCLUSIONS

The yield of conditioned seeds of the first, second and third years of life of the varieties of alfalfa depended on the cultivation conditions. Drip irrigation, regardless of the year of its application, favored for a significant increase in the yield. Zoryana variety had an advantage over Unitro variety both under irrigated and non-irrigated conditions. Application of the growth regulators Agrostimulin, Lucis, Emistim C, Garth increased seed yield, root mass accumulation, the rate of atmospheric nitrogen fixation in the alfalfa varieties. The best results by all the traits were obtained under the application of the preparation Garth. Its application is an effective technological measure allowing increase the production of alfalfa seeds, the accumulation of root mass and biological nitrogen in the soil.

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