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INFLUENCE OF BIOLOGICAL FERTILIZATION ON VEGETATIVE BEHAVIOUR AND PRODUCTIVITY OF GREENHOUSE EGGPLANT

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Abstract

A field experiment was conducted between 2013-2014 in order to establish the influence of organic fertilization on the vegetative behaviour and productivity of greenhouse eggplant, Traviata variety, in conditions of conversion to biological production. Several variants were tested: $N_{24}P_{12}K_{12}$+Wuxal Macromix, Arcobaleno Super+Hemozym+Amino Total, Italpolina+Biorex+Duetto+Guanito+Biofa, Naturale+Osmo+Nutri Algafid. Best vegetative characteristics had variants fertilized with Italpolina+Biorex+Duetto+Guanito+Biofa by mass fruiting values compared to the control were 115.87% for the mass of branches, 105.38% for the number of leaves, 146.19 to fresh mass of the leaves, 127.15% for the mass of fruits, 131.44% for fresh mass of the whole plant. The highest yield and total yield form plants grown after organic fertilization with Naturale+Osmo+Nutri Algafid, respectively 455.55 and 2049.44 kg / da. The results obtained showed that the Naturale+Osmo+Nutri Algafid is the most suitable for bioproduction of greenhouse eggplant.

Key words*: eggplant, biological production, vegetative behaviour, yeld, greenhouses.*

INTRODUCTION

Eggplant is a traditional vegetable crop in Bulgaria. Its fruit have strong taste and nutrient qualities due to the contents of sugar, starch, proteins, Vitamin C, etc. Around 65-70% of the whole production is used for manufacturing in the canning factories. There are various ways for preparation of eggplants- cooked, canned, stuffed, in pickles (a dish made of highly seasoned aubergines), in aubergine paste, fried. The eggplant is consumed in large numbers as it is one of the favorite vegetables in our country and abroad.

High eggplant yields can be obtained if certain fertilization norms and foliar feeding are properly applied and scientifically proved (Janas et al., 2002; Lopez-CantareroI et al., 1998; Lopez-Cantarero-I et al., 1997). In certain developmental stages vegetables, in this case the eggplants, have a strong need of nutrients– usually, these are the stages of fast growth, accumulation of vegetative mass, formation of generative organs. Plant nutrition in these stages of development leads to higher yields (Doykova, 1976).

In relation to the environmental protection and the nutritive value of production, extended research work has been conducted over the last years for examining the effectiveness of the biological fertilization on eggplant vegetation and production.

The present study aims at optimizing the nutrition of eggplants, biologically cultivated in unheated polyethylene greenhouses, and establishing the influence of the used bio-fertilizers on the plant vegetation and production activities. Another main aim is the application of a correlation analysis in order to evaluate the dependence between some biometric indicators of eggplant, which are changed under the influence of the used biological fertilizers.

MATERIALS AND METHODS

Several field experiments on alluvial-meadow soil were conducted in the period 2013-2014, in the polyethylene greenhouses at the Agricultural University-Plovdiv in order to observe the vegetative and productive activities of eggplants.

2500 eggplants/da were planted from *Traviata* variety by the following scheme: 40+85+70+85+40 X 50 cm. Previous analyses were conducted for the soil supply of nutritive

elements, as well as for the existent research data about the influence of the biological fertilization on yield and fruit quality. On this base, a scheme was worked out to describe the conducted experiment and the types of organic fertilizers. The following fertilization variants were tested: $N_{24}P_{12}K_{12}$+Wuxal Macromix, Arcobaleno Super+Hemozym+Amino Total, Italpolina+Biorex+Duetto+Guanito+Biofa, Naturale+Osmo+Nutri Algafid.

The tests were set by the block method in four repetitions, with the field plot size of 16.8 m^2, and the result plot- 10.4 m^2. The eggplant plants were cultivated in unheated polyethylene greenhouses, in the conditions of a transition to biological production.

The granule fertilizers were used as basic fertilization material with sufficient soil processing in the following norms: N- 24 kg/da, P_2O_5- 120 kg/ha, + K_2O – 120 kg/ha, Arkobaleno- 1000 kg/ha, Italpolina- 250 kg/ha, Biorex- 250 kg/ha, Duetto-240 kg/ha, Guanito-250 kg/ha, Naturale- 1000 kg/da. Osmo Bio garden was used in a norm of 1000 kg/ha by four-time nutrition starting from the phenophase "beginning of fruit formation" every 15 days.

Nitrogen was applied at equal parts by four-time nutrition starting from the phenophase "beginning of fruit formation" every 15 days. Four-time nutrition with Hemozym was applied through fertigation from the start of phenophase "beginning of fruiting" every 15 days. There was application of Wuxal Macromix, Amino Total, Biofa and Nutri Algafid – two-time foliar feeding for three weeks after planting and 10 days later. There was foliar spray with Wuxal Macromix in a dose of 5000 ml/ha; with Amino Total-250 g/ha; with Nutri Algafid- 1000 ml/ha, with Biofa- in a dose of 0.5%.

The following fertilizers were used in the present study:

Arkobaleno – it contains nitrogen, phosphorus, potassium in a complete organic form, as it is not a subject of washing. It degrades slowly and provides the plant with nutritive elements for the whole vegetative period, it allows balanced growth. It improves the quality and storage of the production- it gradually restores the fertility and humus, it does not contain hard urban waste. It consists of the following: organic nitrogen (N) 4 5 %, phosphorus anhydride (P_2O_5) 3.5%, potassium (K_20) 3.5%, calcium (CaO) 5-8 %, magnesium (MgO) 0.8-1%, organic carbon (C) of biological origin 30 %, organic substance (CX1.724) 55-60%, extracting organic substance (of organic substance) 30-35%, humificated organic substance (% of organic substance) 12-14%, humificated organic substance (% of extracting substance) 38-40 %, humification percentage (HR) 10-13 %, humification degree (DM) 40-42 %, humification index (Hi) 1.3-1.4 %, iron (Fé) 3100-3200 ppm, boron (B) 40-50 ppm, copper (Cu) 190-200 ppm, manganese (Mn) 850-900 ppm, zinc (Zn) 550-560 ppm.

Amino Total Grow is an organic fertilizer used for active growth and juicier fruit without nitrates. Its organic substances are a formulation of organic fertilizer, which acts as fast absorbable complex food. It contains: common N > 17%; organic N >7%; amino acids > 43%; organic substances - 22%; pH 3.5-5.5. It also contains 18 types of L-amino acids, which increase the protein synthesis. It stimulates the photosynthesis and the absorbing of nutrients in plants as it stimulates the stoma opening. It makes fruits bigger and juicier. It increases the activity of soil microorganisms, as it improves the mineralization of organic material. It acts as an organic catalyser and has a positive effect on the yield quality and quantity.

Italpollina (4N - $4P_2O_5$- $4K_2O$) is dried poultry fertilizer. The high contents of organic substance and active elements for a short time help the increase of microbiological, physical (structure, water content), chemical (buffering) properties of soil. All these advantages lead to the reduction of losses of nitrogen, phosphorus and microelements. Italpollina is rich in humino-active organic substances, microelements and useful micro-flora. It contains: common nitrogen (N) 4%, phosphorus (P_20_5) 4%, potassium (K_20) 4%, water-soluble magnesium (M_2O) 0,5%, water-dissolvable iron (Fe) 0.8%, water-soluble boron (B) 0.2%, organic carbon (C) 41%, organic substance 70.7%, humino-acids 5%, fulvic acids 12%, humidity 12%, pH 7.

Biorex is a biological soil fertilizer, which contains: nitrogen (N) organic-2.8%; total

phosphorus pentoxide (P_2O_5); water-soluble potassium oxide (K_2O).

Duetto is suitable for fertilization of crops with quick growth rates (leaf and fruit vegetables), and for crops that require a great quantity of potassium for which quality is the most important factor of production. Duetto releases a great quantity of organic substance, which improves the soil structure and activates the micro-organisms, reducing soil exhaustion.

Guanito ($NPK_{6.15.2} + {}_2MgO + {}_{10}CaO$) is the organic fertilizer designed to supply a high quantity of organic nitrogen and phosphorus, 100% assimilable. The precious and exclusive raw-material (guano) is the result of a careful selection, which guarantees low salinity and gradual release of elements. Since the phosphorus of Guanito is organic, it is not subjected to insolubilization processes and remains for months completely available in crops.

Hemozym N-K 4.5-6 is a liquid organic mineral fertilizer, which is obtained by the processing of beef manure with potassium phosphate, giving rise to a formula with high biological activity and action. Blood proteins undergo weak hydrolysis, which gives rise to peptides with low molecular weight (< a 2000 Daltons) and aminoacids which, observing their natural Laevogyra configuration, are readily assimilated by the plant through its root apparatus. The total organic nitrogen of hemozym N-K 4.5-6 is, in its greater part, ready to be used for crop needs, mostly in vegetative restoration, with high cost-effectiveness greater than 90%, in contrast to what happens with mineral fertilizers, where nitrogen gets lost to a great degree because of air volatility and soil ashiness (lye). Composition: nitrogen (N) total 4.5%; nitrogen (N) organic 4.5%; potassium (K_2O) water-soluble 6%; carbon (C) organic of biological origin 17%.

Wuxal Macromix is a suspension with well balanced ratio of NPK and trace elements to improve overall growth and quality of production of all crops. It prevents the occurrence of chronic and acute lack of nutrients at critical moments. It improves the sustainability of stress conditions. It regulates the pH of working solution. It contains trace elements in the form chelate. Superchhelatiring provides rapid absorption of trace elements. Application in vegetables: 2-3 weeks after planting, every 8 - 10 days, in a dose of 400 - 5000 ml/ha.

Biofa is an extract of brown seaweeds (kelps), a natural product obtained by cold extraction, preserving all the properties of seaweeds. Biofa is fast absorbable complex food and an anti-stress factor for plants. It leads to strengthening of the stalk and the root system. It takes part in the synthesis of many cell enzymes, which help for faster growth. It helps for the mass flowering and the preservation of blooms. It improves fruit quality due to the contents of phosphorus and potassium in it, which are easily absorbable in their bioactive form. It has an autoimmune effect – a natural stability of plants. Biofa is used for leaf application and for fertigation. The lye of seaweeds forms a very thin layer on the leaf surface, which preserves the plants from diseases (such as mildew and rust). The fertilizer contains organic substances 9%, alginic acid 4%, natural plant hormones >300 ppт, total nitrogen N 0.20%, total phosphorus /P_2O_5/ - 8%, soluble potassium /K_20/ -14% ${}_4N:{}_30P:{}_8K$ + 10% OM + PGR. Application dose**:** 0.3 - 0.5 %. It is applied in all plants 2-3 times a year.

Nutri Algafid is an organic liquid fertilizer containing N-5%, P_2O_5-20%, K_2O- 7%. PGR growth enzymes, amino acids >1%, organic substances >15%, pH 8- 9. The organic substances in Nutri Algafid are formulation of an organic liquid fertilizer. Due to its formulae, it acts as fast-absorbable complex food. It increases plant sustainability to drought, heat and stress, the negative influence of pesticides and diseases. It also stimulates the development of the root system, as it increases the root zone and stimulates the productive system. It regulates the soil acidity and improves the absorbing of nutrients. It acts as an organic catalyser and improves the yield quality and quantity. It is applied in a dose of 50-100ml/da, appropriate for seedling treatment – before and after pricking off, 2-4 times every 7-14 days.

The following observations and analyses were conducted during the experiment:

Biometric indicators – stem height (cm); stem mass (g); number of leaves (num.); mass of leaves (g); number of branches (num.); mass of

branches (g); mass of the whole plant (g). They were determined by means of biometric measurements of 12 plants from each variant in the following phenophases: planting, beginning of fruiting and mass fruting.

Plant productivity- fruit number per plant (num.); fruit mass per plant (g). They were determined by measurements of 12 plants from each variant during the phenophases beginning of fruiting and mass fruting.

The evaluation of the correlation dependences in the tested variants was made on the base of the following biometric indicators: plant height - x_1; stem mass - x_2; number of leaves - x_3;mass of leaves - x_4; number of fruit - x_5; mass of fruit - x_6; mass of the whole plant - x_7. The experimental data was processed through a correlation analysis [Barov, 1982; Genchev at all., 1975]. The relationship between the examined indicators was established and evaluated. It was expressed by the correlation coefficient *r*, which was defined by the statistical program SPSS 18. This approach was used for determining important agronomic indicators in mutant hybrids of corn [Ivanova at all., 2014] and pepper varieties [Chozin at all., 2013, Todorova at all., 2003].

Yield structure: early yield– from the first five harvests, kg/da; total yield, kg/da. The evaluation of the factors` impact was calculated by the method of Plokhinski (Lakin, 1990). It was determined as part of the intergroup variation in the total variation. The sum of squares was used, calculated by the following formula:

$$h_x^2 = \frac{D_x}{D_y},$$

where D_x - is the sum of factor squares, *x,* D_y - total sum of squares (SS). For the *total yield* indicator, an influence was established of the factors *fertilization* and *year*, as well as their interaction.

RESULTS AND DISCUSSIONS

Influence of the leaf fertilization on the vegetative activities of eggplant

There are some established dependences related to the influence of foliar spray on the vegetative development of plants. There are differences in the dynamics of plant growth, number of branches, number and mass of leaves, number and mass of fruit, mass of the whole plant in the separate phenophases, as well as by the type of organic fertilization and foliar feeding.

Average for the period 2013-2014, in phenophase of beginning of fruiting the following tendency was observed: the tested plants of combined soil fertilization with Italpolina+Biorex+Duetto+Guanito and foliar spray with Biofa considerably have higher values of their biometric indicators in comparison with the rest of the variants of organic fertilization. All variants of organic fertilization have weaker vegetative growth than the control plants, fed with combined soil and foliar mineral fertilization (Table 1).

Table 1. Influence of organic fertilization on the vegetative and productive behaviour of plants average for the period 2013-2014

phenophase	Variants	stem		branches		leaves		fruit		Mass of whole plant,
		H, cm	mass, g	number	mass, g	number	mass, g	number	mass, g	
Beginning of fruiting	1	63.75	63.50	1.50	21.50	29.00	121.00	2.00	115.00	267.50
	2	55.65	38.50	1.00	8.50	19.50	62.50	1.50	67.00	150.50
	3	60.50	38.00	1.50	10.50	24.50	63.00	1.00	71.50	161.00
	4	56.50	36.50	1.50	20.50	26.50	87.00	1.50	78.00	193.50
Mass fruiting	1	85.70	87.50	2.00	31.50	46.50	111.50	1.50	261.50	493.00
	2	83.80	72.00	2.00	25.00	44.50	118.50	1.50	194.50	410.50
	3	102.00	115.50	2.00	36.50	49.00	163.00	2.00	332.50	648.00
	4	81.55	83.50	2.00	30.00	39.00	115.00	1.00	197.50	426.50

We observe the highest the stem of the control plants applied with $N_{24}P_{12}K_{12}$ + Wuxal - 63.75cm, followed by the plants applied with the organic fertilizers Italpolina + Biorex + Duetto + Guanito + Biofa- 60.50cm and Naturale+Osmo+Nutri Algafid- 56.50cm. For the variants fed with Italpolina+ Biorex+ Duetto+Guanito, the stem height is 94.90% from the control`s one. For the rest of the variants fertilized with biological fertilizers, the stem height is lower than the control`s one with 7.25 and 8.10cm, correspondingly. The slowest stem growth is observed in plants fertilized with Arcobaleno+Hemozym+Amino Total- 55.65cm.

In the stage of mass fruiting, the highest stem is registered in the plants fertilized with Italpolina + Biorex + Duetto + Guanito + Biofa- 102cm, followed by Arcobaleno + Hemozym + Amino Total- 83.80cm. At two variants, where plants are fed with organic fertilizers, stem height development is less than the control one- Arcobaleno + Hemozym + Amino Total and Naturale + Osmo + Nutri Algafid.

The stem mass in the stage of beginning of fruiting is the highest for the control variant ($N_{24}P_{12}K_{12}$ + Wuxal)- 63.50g. After fertilization with organic fertilizers, it varies from 36.50cm for Naturale + Osmo + Nutri Algafid to 38.50g for Arcobaleno + Hemozym + Amino Total. The control plants outmatch the tested variants from 39.37% to 42.52%.

The stem mass reaches its growth maximum in the phenophase of mass fruiting. It is the highest when plants are fertilized with Italpolina + Biorex + Duetto + Guanito + Biofa– 115.50g, which is an increase compared to the control variant with 32.00%. They are followed by the plants fed with Naturale + Osmo + Nutri Algafid-83.50g, as this value is lower than the control with 4.57%.

The increase of plant mass leads to an increase of the number of branches. In the beginning of fruiting, they vary from 1.00 to 1.50 numbers. Plants with the smallest number of branches are those fed with Arcobaleno Super + Hemozym + Amino Total. In the phase of mass fruiting, they reach 2 numbers in all tested plants.

In the beginning of fruiting, the plant mass indicator is the highest for the plants fed with Naturale + Osmo + Nutri Algafid- 20.50g, but it is lower compared to the control with 4.65%.

In the phase of mass fruiting, the variant fed with Italpolina + Biorex + Duetto + Guanito + Biofa has bigger mass of branches than the control plants, with 15.87% of difference.

The biological fertilization has an effect on the number and mass of leaves due to the contents of organic substance and active ingredients. For a short time they increase the microbiological, physical (structure and water contents) and chemical (buffering) soil properties. The faster vegetative growth is also stimulated by the organic foliar fertilization being fast absorbable complex food and an anti-stress factor for plants. Such fertilizers help to strengthen the stem and root system and help for the synthesis of many enzymes in the cell, as they act as an organic catalyzer.

In the phase of beginning of fruiting, the number of leaves is greater for the control plants- 29.00. The other variants with organic fertilization have a smaller number of leaves than the control- 26.50 for Naturale + Osmo + Nutri Algafid, 24.50 for Italpolina +Biorex + Duetto + Guanito + Biofaand 19.50 for Arcobaleno + Hemozym+Amino Total, correspondingly.

From the beginning of fruiting to the mass fruiting, plants form from12.5 leaves for Naturale + Osmo + Nutri Algafid to 25.00 leaves for Arcobaleno Super + Hemozym + Amino Total. In mass fruting, the number of leaves vary from 39.00 for the variants fertilized with Naturale + Osmo + Nutri Algafid to 49.00 for those with Italpolina + Biorex + Duetto + Guanito + Biofa. It can be noticed that among all tested combinations, plants fertilized with Italpolina + Biorex + Duetto + Guanito + Biofa form the greatest number of leaves.

The increase of the number of leaves leads to an increase of their mass by phases of development, as the maximum is in the phase of mass fruiting. In this phase, all variants of biological fertilization have higher leaf mass than the mass of the control variant from 3.14% for plants fed with Naturale + Osmo + Nutri Algafid to 46.19% for plants fed with Italpolina + Biorex + Duetto + Guanito + Biofa. The greatest leaf mass is observed for plants fed with Italpolina + Biorex + Duetto + Guanito + Biofa - 163.00g, followed by plants fed with Arcobaleno + Hemozym + Amino Total- 118.00g.

The organic fertilization helps for the increase of fruit number and mass. In the beginning of fruiting, the fruit number is greatest for the control variant of 2.0 fruits. They are followed by the plants fed with combined soil and foliar biological fertilization with Arcobaleno + Hemozym + Amino Total and Naturale + Osmo + Nutri Algafid, which have formed 1.5 fruits. The variants fed with combined soil and foliar fertilization- Italpolina + Biorex + Duetto + Guanito + Biofa has formed 1.0 fruit.

In the phase of mass fruiting, plants with smallest number of fruit are those fertilized with Naturale + Osmo + Nutri Algafid (1 fruit), the control plants and those fertilized with combined soil and foliar biological fertilizers- Arcobaleno + Hemozym + Amino Total, which have formed 1.50 fruits. Plants with most fruit are those fed with organic fertilizers Italpolina + Biorex + Duetto + Guanito + Biofa- 2.00 fruits.

In the phase of beginning of fruiting, the fruit mass is greatest for the control plants- 115g, followed by plants fed with the organic fertilizers Naturale + Osmo + Nutri Algafid and Italpolina + Biorex + Duetto + Guanito + Biofa–78.0 g and 71.5 g, correspondingly. Fruit mass of the variants fed with soil and foliar organic fertilizers is smaller than the one of the control variant from 37g for plants fed with Naturale + Osmo + Nutri Algafid to 48.00g for plants fed with Arcobaleno + Hemozym + Amino Total. Fruit mass increases most slowly for plants fertilized with liquid organic fertilizer (Arcobaleno + Hemozym + Amino Total)- 67g. It increases most quickly with the application of granule organic fertilizer- Naturale + Osmo + Nutri Algafid- 78 g.

Fruit mass reaches its maximum in the stage of mass fruiting. Its highest value is observed in plants fertilized with Italpolina + Biorex + Duetto + Guanito + Biofa- 332.5g and the control ones- 261.5g. Only plants fed with Italpolina + Biorex + Duetto + Guanito + Biofa exceed the control plants with 27.15%. The rest of the variants fertilized with organic fertilizers have lower fruit mass than the controls.

In the beginning of fruiting, plant mass is the highest for control plants fertilized with $N_{24}P_{12}K_{12}$ + Wuxal-267.50g. For the other variants, values are lower than those of the controls, as they vary from 150.50 for plants fed with Arcobaleno + Hemozym + Amino Total to 193.50g for plants fed with Naturale + Osmo + Nutri Algafid. There are close values between the variants fed with Naturale + Osmo + Nutri Algafid-193.50g and those fed with Italpolina + Biorex + Duetto + Guanito + Biofa-161.00g.

The maximum of plant mass is reached in the phase of mass fruiting. In this phenophase the plant mass varies from 410.50g for plants fed with Arcobaleno + Hemozym + Amino Total to 648.00g for those cultivated with Italpolina + Biorex + Duetto + Guanito + Biofa. Higher values than the controls are observed for plants fertilized with Italpolina + Biorex + Duetto + Guanito + Biofa c 31.44%. In the rest of the variants, differences are on behalf of the control plants- with 13.49 for plants fed with Naturale + Osmo + Nutri Algafid and 16.73 for those fed with Arcobaleno + Hemozym + Amino Total, correspondingly.

Positive correlations between the structural elements are established, which determine the productivity of the examined variants (Table 2).

Table 2. Correlation dependences in eggplant in the phenophase of *beginning of fruiting* average for the period 2013-2014

	x_1	x_2	x_3	x_4	x_5	x_6	x_7
x_1	1	0.829	0.727	0.674	0.354	0.815	0.751
x_2		1	0.640	0.881	0.804	0.963*	0.913
x_3			1	0.843	0.456	0.810	0.859
x_4				1	0.859	0.969*	0.994**
x_5					1	0.811	0.823
x_6						1	0.988**
x_7							1

High positive values of r (r= 0.988÷0.994) are registered between the whole plant mass and the leaf mass; the fruit mass.

The correlation dependence between the fruit mass and the stem mass, the leaf mass is less expressed (r = 0.963 ÷ 0.969). The correlation dependences between the plant height, the number of leaves, the number of fruit and the rest of the indicators are mathematically unproved. This analysis can serve for predicting the productivity of variants and their advantages.

After the conducted correlation analysis in the phase of mass fruiting (Table 3), very high correlation dependence is established between the whole plant mass, the stem mass

and the fruit mass (r = 0.978 ÷ 0.986). High positive values of r (r=0.960÷0.972) are registered between the plant height and the leaf mass, the whole plant mass, as well as the number of leaves and the number of fruit.

Table 3. Correlation dependences in eggplant in the phase of *mass fruiting* in the period 2013-2014

	x_1	x_2	x_3	x_4	x_5	x_6	x_7
x_1	1	0.932	0.788	0.967*	0.896	0.936	0.972*
x_2		1	0.619	0.887	0.708	0.945	0.978**
x_3			1	0.639	0.960*	0.826	0.768
x_4				1	0.811	0.824	0.901
x_5					1	0.846	0.834
x_6						1	0.986**
x_7							1

Despite the fact that the organic fertilizers have lower contents of nutrients than the minerals, data shows that they can provide plants with the necessary nutritive elements at great extent. Organic fertilizers also help for the increase of the formed vegetative mass in all phases of development. The maximum of all indicators for most of the variants is reached in the phase of mass fruiting. Among the plants with foliar fertilization, the variant fertilized with Italpolina + Biorex + Duetto + Guanito + Biofa is outlined. It has the highest influence on most of the examined indicators.

Yield alternation depending on the fertilization type

Depending on the combination of fertilization and the type of the applied biological fertilizers, eggplant yields vary differently average for the period. Doykova (1976) has established that eggplant is a highly-productive crop. The use of fertilizers has a great effect even in the presence of high contents of nutrients in soil.

The comparative analysis shows that the highest early yield is obtained by the control plants fertilized before planting with $N_{24}P_{12}K_{12}$ and fed with Wuxal foliar fertilizer during vegetation. Among the variants tested with biological fertilizers, the highest yield is the early yield after the application of the combinations: Naturale + Osmo + Nutri Algafid and Italpolina + Biorex + Duetto + Guanito + Biofa (Table 4).

Table 4. Comparative evaluation and provability of the differences between the total eggplant yield average for the period 2013-2014

Variants	Early yield		Total yield	
	kg/ha	provability	kg/da	provability
1. $N_{24}P_{12}K_{12}$+Wuxal	5511.00 ^{b}	ns	21975.37 ^{c}	ns
2. Arcobaleno+Hemozym+Amino Total	495.20^{a}	*	10438.50^{a}	*
3. Italpolina+Biorex+Duetto+Guanito+Biofa	1966.10^{a}	*	14202.70 ^{b}	*
4. Naturale+Osmo+Nutri Algafid	4455.50 ^{b}	ns	20493.53 ^{c}	ns
a, b, c, …degree of provability at $P_{95\%}$				

The early yield is the highest for the variants ($N_{24}P_{12}K_{12}$ + Wuxal)- 5511.0 kg/ha. After the combined foliar feeding with organic fertilizers, the early yield varies from 495.2 kg/da- for plants fed with Arcobaleno+Hemozym+Amino Total to 4455.5 kg/ha- for those fed with combination of Naturale + Osmo + Nutri Algafid. Compared to the control, the yield is lower with 91.01 and 19.15%, relatively. When during vegetation plants are fed with Hemozym and Amino Total, with Arcobaleno fertilizer, the yield is the smallest- 5015.8 kg/ha lower than the control. After the application of combined organic fertilization with Italpolina + Biorex + Duetto + Guanito + Biofa, yield is 3544.9 kg/ha lower, compared to the non-fertilized variants and 1470.9 kg/ha higher compared to the variants fertilized with Arcobaleno+Hemozym+Amino Total. Compared to the control- non-fertilized plant fertilized with Osmo and Nutri Algafid and Naturale, the early yield is 1055.6 kg/ha lower. Compared to those variants cultivated with Arcobaleno and fed with Hemozym and Amino Total- the yield is 3960.2 kg/ha higher. Plants cultivated with Naturale and fed with Osmo and Nutri Algafid has the highest yield with the use of biological fertilizers - 80.85% compared to the control- $N_{24}P_{12}K_{12}$+ Wuxal.

There is a higher effect due to the foliar feeding with organic fertilizers when the fertilization

during vegetation is combined with granule biological fertilizers.

The total eggplant yield shows that the lowest yield (10614.1 kg/ha) is observed in variants fed with Arcobaleno+Hemozym+Amino Total, and the highest yield (21975.4 kg/ha) is observed in the control plants fed with mineral fertilizers. In the variants with combined organic fertilizers, yield is lower than the control plants, from 6.74% for variants with Naturale + Osmo + Nutri Algafid to 52.50% for variants with Arcobaleno+Hemozym+Amino Total. Variants applied with Naturale have the highest productivity after combined feeding with organic soil and foliar spray- yield is 1481.9 kg/da lower than the control one. The variant fed with the organic fertilizers Italpolina + Biorex + Duetto + Guanito exceeds the yield of that fed with Arcobaleno with 3764.2 kg/da.

There is similar effect of the variant fertilized with foliar fertilizer Nutri Algafid and Naturale + Osmo and the variant fertilized with Wuxal after the application of $N_{24}P_{12}K_{12}$ in soil. The used combination Naturale+Osmo+Nutri Algafid increases yields with 96.33% compared to Arcobaleno + Hemozym + Amino Total. The increase compared to Arcobaleno + Hemozym + Amino Total for Italpolina + Biorex + Duetto + Guanito + Biofa and Naturale + Osmo + Nutri Algafid is with 3764.2 kg/ha and 10055.9 kg/ha, correspondingly.

Table 5 shows the dispersive analysis conducted to establish the influence of the factors year (A), fertilization variants (B) and their interaction on the total yield.

Table 5. Two-factor dispersive analysis of the factors: A – year and B – fertilization variants on the total yield

Source of variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*	*power of influence*
Year (A)**	3138406	1	3138406	27.25733	0.000	4.49	27%
Variants of fertilization (B)***	4992447	3	1664149	14.45328	0.000	3.24	42%
Interaction*	1845307	3	615102.2	5.342216	0.01	3.24	16%
Errors	1842238	16	115139.9				15%

***, **, * - proved at $p \leq 0.001$, $p \leq 0.01$ and $p \leq 0.05$, correspondingly; n.s. – unproved

The results show that the strongest influence on the total yield has B factor- fertilization, with dominating influence of 42% and clear provability $p \leq 0.001$ on the indicator change. The second place is for A factor- year, with influence of 27%, and with 16 %- the interaction of both factors, correspondingly.

CONCLUSIONS

Foliar feeding with organic fertilizers, completed and supplied with biological fertilization, stimulates the vegetative activities of plants. The effect is expressed most strongly in the phenophase of mass fruiting, as it is the highest with the application of Italpolina + Biorex + Duetto + Guanito + Biofa, where the formed fresh vegetative mass increases to 31.44%, compared to the control. Indicators that characterize the vegetative behaviour have close values after fertilizing with biological fertilizers Arcobaleno + Hemozym + Amino Total and Naturale + Osmo + Nutri Algafid. As a result of the conducted correlation analysis, correlation dependences are established between the examined seven biometric indicators. In two phenophases there are high positive values of r between the fruit mass and the whole plant mass. There is lower dependence between the fruit mass and the mass of leaves and stem. Correlation dependences between the stem mass and the number and mass of leaves are mathematically unproved.

The observed correlation dependences show the extent of influence of each indicator for the formation of eggplant yield after fertilizing with the biological fertilizers used in the study.

Taking into account the supplying fertilization and leaf feeding, the early yield after biological fertilization is lower than the control variants with a difference from 1055.6 kg (19.15%) to 5015.8kg (91.01%), and the standard yield from 1481.0kg (6.74%) to 11536.9 kg (52.50%).

After organic fertilization, the highest yield and total yield form the plants fertilized with Naturale + Osmo + Nutri-Algafid. The conducted two-factor correlation analysis registers that for both factors (year conditions

and fertilization variants) separately and in interaction, the influence of yield is statistically proved at a high extent ($p \leq 0.001$).

The fertilization regime has the strongest influence on the indicator variation (42%), followed by year conditions (27%) and their interaction (16%). These results are synchronized with the results that define the yield.

Biological fertilization could compensate the mineral fertilization at a great extent in relation to the vegetative behaviour and productivity of plants. The biological cultivation of eggplant could be used for experimental and ecological-oriented middle-early field production.

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