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THE USE OF BLACK SEA SAPROPELS AS AMENDMENT FOR GROWING EGGPLANTS (*SOLANUM MELONGENA L.)*

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Rezumat: În timpul perioadei 2012-2013 a fost efectuat un studiu cu privire la efectul utilizării sedimentelor organice-minerale de adâncimi mari (sapropelul) din Marea Neagră ca amendament pentru substratul sol aluvionar de luncă-gunoi de grajd utilizat la producerea răsadului de vinete cv. Patladjan 12. Rezultatele obţinute după doi ani de experimente de teren au arătat că introducerea a 30 g/kg de sapropel din Marea Neagră măreşte pH-ul substratului de sol-gunoi de grajd de la 7,42 la 7,74 unităţi şi îmbunătăţeşte parametrii de creştere a răsadului de vinete precum urmează: înălţimea tijei centrale cu 9,20%, lăţimea tijei centrale cu 0,98%, iar numărul de frunze cu 8,15%. Potrivit experimentului de teren, randamentul standard timpuriu de vinete (fructe) a crescut cu 14% în cazul plantelor cultivate în varianta I, iar randamentul standard total – cu 10,6%, comparativ cu varianta martor.

Cuvinte-cheie: *Solanum melongena;* Amendament de sol; Îngrăşământ organic-mineral; Creştere; Productivitate.

Abstract: During the period 2012-2013, a study was made on the effect of using deep-water organic-mineral sediments (sapropels) of the Black Sea as amendment for alluvial meadow soil (*Calcaric Fluvisol*) – manure substrate used for seedlings production of eggplant cv. Patladjan 12. The results obtained after two years of field experiments showed that the introduction of 30 g/kg of Black Sea sapropels increases the pH of soil-manure substrate from 7.42 to 7.74 units and improves the growing parameters of eggplant seedlings as follows: the height of the central stem by 9.20%, the width of the central stem by 0.98% and the number of leaves by 8.15%. According to the field experiment, the early standard yield of eggplant fruits increased by 14% for the plants grown in Variant I and the total standard yield - by 10.6% compared with the control variant.

Key words: *Solanum melongena;* Soil amendment; Organic-mineral fertilizer; Growth; Crop yield.

INTRODUCTION

The eggplant (*Solanum melongena L.)* is a traditional vegetable crop in Bulgaria and other European countries. Eggplant fruits have an excellent taste and nutritional value due to the content of sugars, starch, proteins, ascorbic acid etc. Prepared in different ways, it is consumed widely and it is one of the favorite vegetables not only in Bulgaria, but also abroad. The average yield of this crop is relatively low, despite its large biological potential. For our country it is 2716 kg/da, while the worldwide average yield is about 1670.36 kg/da. The reasons are due mainly to the agro-climatic, economic and organizational conditions. In many cases, lower yields and their variations are the result of violations of applied technology (Kostadinov, K. 2007.)

Seedlings production, according to Kr. Michov et al. (2001), represents an important stage of the vegetable crop vegetation, which influences the quality and yield of the plant production. Substrate composition is also essential for the production of high qualitative seedlings along with the mineral nutrition, both leading to higher yields of crop production. According to St. Gorbanov et al. (2005), soils and substrates have to be periodically enriched with organic-mineral fertilizers. The presence of organic matter represents a favourable condition for a better assimilation of the nitrogen by plants. The most commonly used substrates are peat-moss and perlite enriched with manure. According to D. Cholakov et al. (2003) the substrate composition strongly influences the biological potential of plants. Enriching the peat-perlite-manure substrate with Black sea sapropels, at an amount of 30 g/kg, increases the biometric parameters of tomato seedlings cv. Rila F_1 and the total yield of plant production by 9.3%. On the other hand, sapropels increase the content of dry matter, which made the tomato plants more resistant to low temperature at the beginning of vegetation in glasshouse conditions.

Black sea sapropels represent a unique natural phenomenon. The initial idea of their implementation in agriculture, according to T.S. Bmins (1994), was connected with the use of lake and marsh sapropels. An important reason for their investigation, according to D. Dimitrov et al. (2000), lays in the favourable organic-mineral composition of sapropels. G. Georgiev (2005) has established that sapropels possess pesticide properties and stimulate the growth of some vegetable crops, most probably due to the content of some trace elements in the form of humic acid salts. According to V. Koteva et al. (1993)

the long standing mineral fertilizing has a negative influence on the soil reaction and the content of humus in some soil types. According to S. Todorova et al. (2012), natural reserves of mobile forms of nitrogen and especially phosphorus from the soil are not sufficient for the normal growth and development of plants. It is necessary to use organic and mineral fertilizers, but the rates must be based on these natural reserves of soil nutrients. In this way, it will be avoided the excessive use of fertilizers (especially nitrogen fertilizers), it will be minimized the negative environmental effect and somewhat, it will be reduced the cost of production. N. Nikolov (2014), for example, has used marine sapropels to neutralize the acidity of different types of acidic soils to neutral and low alkaline. Such soils are favourable for growing certain crops, sensitive to acidic soil reaction, such as legumes, alfalfa, carrots etc.

The aim of the present work was to study the effect of Black sea sapropels on the growing parameters of eggplant seedlings cv."Patladjan 12" and to establish their influence on the early and general standard yield of eggplant fruits grown in field conditions.

MATERIAL AND METHODS

1. Seedlings production

The investigation was carried out in the experimental field of Plovdiv Agricultural University in the period 2012-2013. Air dried sapropels, screened by sieve 1 mm at an amount of 30 g/kg (Variant I), were added to the soil-manure substrate and regularly irrigated. The type of soil used in the experiment was alluvial-meadow soil (*Calcaric Fluvisol*). The correlation soil-manure was 2:1. After the incubation period of a month, on the 15th of April, the plants of the vegetable crop eggplant cv. Patladgan 12, growing in styrofoam tables in phase crossing, were planted in plastic plant pots with the diameter 100 mm and in the amount of soil-manure substrate of 0.5 kg. As a control variant, there have been used eggplants in pots with soil-manure substrate without the addition of sapropels. All the necessary agro-technical activities – irrigation and weeding – have been made in time including the fertilization with ammonium nitrate at a dose of 1 g per plant once a week after the planting in pots.

2. Composition of Sapropels

The samples of marine sapropels were taken from a depth of 1200 m, thanks to a scientific expedition of specialists from the Institute of Oceanology, BAS, Varna, using the research vessel "Akademic". According to Nikolov et al. (2014), marine sapropels possess the following chemical composition: SiO_2 - 397.6 g/kg, $Ń_{total}$ (organic matter and carbonates) – 199.7 g/kg, CaO - 154.6 g/kg, MgO - 26.8 g/kg, Na_2O - 21.3 g/kg, $E_2Î$ - 18.3 g/kg, TiO_2 - 7.0 g/kg, P_2O_5 - 1.32 g/kg, $Ŕ1_2Î_3$ - 116.9 g/kg, FeO - 45.7g/kg, MnO - 0.4g/kg, Cr - 50.0 g/t, Ěî - 36.40 g/t, Zn - 65.82 g/t, Mn - 383.42 g/t, Cu 36.63 g/t, Ni - 49.75 g/t. The organic matter calculated as total humus content amounted to 68.5 g/kg.

2. Determination of pH

The pH values in water medium (distilled water) of the tested soil-manure substrate, used as a control variant and those of the soil-manure substrate with sapropels were determined using a pH meter, Model OP-211 /1 (ISO 10390).

3. Biometric analysis.

The biometric analysis of the vegetable crop eggplant cv."Patladjan 12" was made using a standard method (Dimova et al, 2005). The analysis included the following biometric parameters: the height of the central stem (cm), the width of the central stem (mm) and the number of leaves. The study was made when the plants reached the fifth – sixth leave phase, immediately before planting the eggplants in a permanent place.

4. Field experiment

The eggplants were grown according to the technology of medium-early field production and the following variants were tested: 1. Variant I – seedlings, grown in a substrate where 30 g/kg of sapropels have been added; 2. Control variant - plants grown in manure-soil mixture without sapropels. Total area of the experimental plot was of 16 m^2 and the calculated one – 12.8 m^2. The type of used soil was Alluvial meadow soil (*Calcaric Fluvisol*). The experiment was settled in the experimental field of Plovdiv Agricultural University in the period 2012-2013 using the block method in four replications. Each of them was over 7 eggplant plants. The planting was done on the 15th of May. During the vegetation period, the necessary agricultural activities – irrigation, weeding and fertilizing – have been made in time. The first fertilization with ammonium nitrate was done on the 8th of June, at a rate of 18

kg/da of fertilizer per plant, and the second – on the 28th of June, using potassium nitrate at a rate of 18 kg/da. It was recorded the productivity of plants and namely: early yield, including the first three harvests (kg/da) and total yield, including all seven harvests (kg/da) for the two investigated years.

5. Statistical data processing

The processing of statistical data concerning the biometric parameters of seedlings, as well as at the early and the total yield of eggplant production was made using the method of analysis of variance (ANOVA).

RESULTS AND DISCUSSIONS

During these 2 years of investigations there was no significant difference between the pH values of the tested soil-manure substrate (Control) and Variant I - soil-manure substrate where 30 g/kg of sapropels have been added. The used control soil-manure substrate was weak alkaline - pH 7.40, most probably due to the presence of manure. As for the Variant I, after a month of incubation period (May-June), the addition of sapropels lead to the increase of pH with 0.11 units - 7.55 and to the end of the vegetation period, in October, pH reached the value of 7.74. These values are in the acceptable limits of favourable soil reaction used for eggplant growing. The introduction of higher amounts of sapropels is associated with the inhibition of seedlings growth, because of higher pH levels. Cholakov et al. (2003) have established that the introduction of sapropels at an amount of 50 g/kg and more deteriorates the mineral nutrition of tomato seedlings, because pH changes – pH 8.0-8.2. At these values, some micronutrients as Fe and Mn pass into insoluble forms and can't be assimilated by the plants. The experimental data obtained for pH values show that the influence of sapropels on the soil-manure substrate possessing weak alkaline reaction is significantly less pronounced (Fig.1). More pronounced, according to Nikolov (2014), is the neutralizing ability of marine sapropels on highly acidic soils, such as Distric Cambisol and Planosol, because of the activation of exchange bases in sapropels composition.

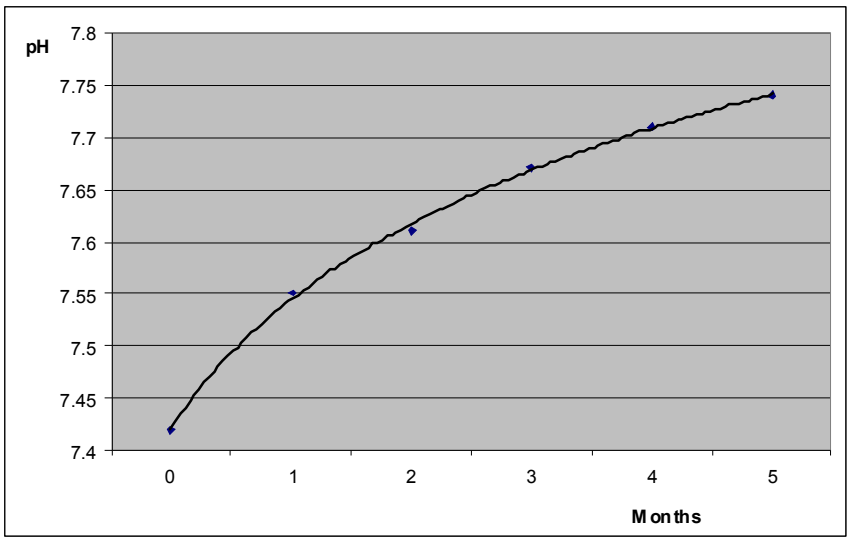

***Fig.1**. pH values of soil-manure mixture with sapropel addition, during the vegetation period.*

During the first investigated year, it was made the analysis of the following biometric parameters of eggplant plants cv."Patladjan 12": the height of the central stem (cm), the width of the central stem (mm) and the number of leaves. The data obtained from biometric analyses of 10 tested eggplant seedlings show that in Variant I, containing 30 g/kg of sapropels, the central stem of the eggplant was higher by 9.20% in comparison to the average value obtained from the control plants.

The width of the central stem of eggplants tested in Variant I was by 0.98% greater in comparison to the one of the control seedlings. The number of leaves was with 8.15% higher compared to the control plants**.** The statistical difference between the control and the studied variant was demonstrated in terms of the number of leaves (Tab. 1).

The experimental data show that seedlings produced in soil-manure-sapropels mixture have a higher

Table 1. *Biometric parameters of eggplant plants cv. "Patladjan 12"*

№	Variants	Height of the central stem /cm/	Width of the central stem /mm/	Number of leaves
1	**1. Control**	14.12	4.70	5.30
2	**2. Variant I**	15.36	4.77	6.50
3	**Difference, %**	**9.20**	**0.98**	**8.15**
4	**GD 5%**	1.98	2.54	1.01
5	**GD 1%**	2.86	3.69	1.46
6	**GD 0.1%**	4.30	5.53	2.20

biological potential, which is reflected positively in the early and total yield of eggplant plants grown in field conditions. The average value of the early standard yield of the Variant I for the both investigated years was by 14.0% higher in comparison to the control variant. Total standard yield of Variant I was respectively by 10.8% higher compared to the Control variant (Tab. 2). The statistical difference between the control and the studied variant was proven.

Table 2. *The yield of eggplant fruits cv. "Patladjan 12"*

Variant	Early yield					Total yield			
	2012	2013	Average 2012-2013			2012	2013	Average 2012-2013	
			kg/da	% to control	% to total yield			kg/da	% to control
1. Control	1820	1740	1780	100	39.4	4438	4588	4513	100
2. Variant I	2103	1953	2028	114	40.6	4980	5004	4992	110.6
GD 5%	15.68	16.6				19.16	13.94		
GD 1%	22.7	24.04				27.75	20.19		
GD 0.1%	34.06	36.07				41.62	30.29		

CONCLUSIONS

The effect of introduction of Black sea sapropels was studied on the seedlings production of vegetable crop eggplant cv. Patladjan 12. It has been established their influence on the growing parameters, such as the height and the width of the central stem, and number of leaves, as well as on the standard yield of eggplant production grown in field conditions. Being incubated in an amount of 30 g/kg, the sapropels stimulate the growth of the stem, as well as the formation of leaves. Also, the content of microelements and the organic matter in sapropels composition have a dominating impact on the growth parameters of the tested plants. The experimental data obtained during these 2 years of investigations show that the early standard yield of eggplants in Variant I increased by 14% and the total standard yield increased by 10.6%, compared to Control variant (Tab. 2).

The obtained results show that sapropels could be successfully used as a complex organic-mineral fertilizer for the substrates used for seedlings production.

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