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ОПТИМИЗИРАНЕ НА АЗОТНОТО ХРАНЕНЕ ПРИ ДОМАТИ СОРТ "РИЛА" F_1, ОТГЛЕЖДАНИ В НЕОТОПЛЯЕМА ПОЛИЕТИЛЕНОВА ОРАНЖЕРИЯ ЧРЕЗ ИЗПОЛЗВАНЕ НА МОДИФИЦИРАНИ ГРАНУЛИ, СЪДЪРЖАЩИ ПОЛИМЕРИ И ЧЕРНОМОРСКИ САПРОПЕЛИ

OPTIMIZING THE NITRIC NUTRITION OF TOMATOES CV. *RILA* F_1, GROWN IN AN UNHEATED PLASTIC GREENHOUSE, BY USING MODIFIED GRANULES WHICH CONTAIN POLYMERS AND BLACK SEA SAPROPELLES

Николай Николов[1]*, Димитър Чолаков[1], Цвета Москова[1], Дарина Христова[2]
Nikolay Nikolov[1]*, Dimitar Cholakov[1], Tsveta Moskova[1], Darina Christova[2]

[1]Аграрен университет - Пловдив
[2]Институт по полимерите при БАН
[1]Agricultural University - Plovdiv
[2]Institute of Polymers, BAS

***E-mail: oridel@abv.bg**

Резюме

Оптимизирано е азотното торене при ранни домати, сорт "Рила" F_1, отглеждани в неотопляеми оранжерии, с модифицирани гранули, съдържащи амониева селитра, черноморски сапропели и водонабъбващи полимери. При вариант I с гранули, покрити с полимерна мембрана от поливинилов алкохол (ПВА), ранният добив (до 20.06) се увеличава с 6,8%, а при вариант II – с гранули с полимерна мембрана от частично ацетилиран ПВА (ПВА-М) - с 9,3%. Общият стандартен добив при вариант I е със 7,2%, а при вариант II – с 14,3% по-висок в сравнение с контролата. Разходната норма на торене с амониева селитра при варианти I, II е намалена до 49,2 kg/da в сравнение с контролата – 61,5 kg/da. Очаква се реализиране на екоефект поради намаленото замърсяване на подпочвените води и готовата растителна продукция с нитрати, дължащо се на по-равномерното и по-пълно усвояване на амониевия и нитратния азот.

Abstract

Nitrogen fertilization was optimized in early tomatoes cv. *Rila* F_1 grown in an unheated greenhouse with modified granules, containing ammonium nitrate, Black Sea sapropelles and water swelling polymers. In variant (I), with granules coated with a polymer membrane of polyvinyl alcohol (PVA), the early yield (to 20.06.) was increased by 6.8%, while in variant (II) with granules possessing polymer membrane of partially acetylated PVA (PVA-M) the increase was 9.3%. The total standard yield of variant (I) was with 7.2% higher, while in variant (II) it was 13.78% higher compared to the control. The rate of fertilization with ammonium nitrate in variants I and II was reduced to 49.2 kg/da, compared to the control – 61.2 kg/da. An ecological effect is expected because of decreased pollution of the groundwater and plant production with nitrates due to a more even assimilation of ammonium and nitrate nitrogen.

Ключови думи: сапропели, домати сорт „Рила" F_1, ранен и стандартен добив от домати, модифицирани гранули.
Key words: sapropelles, tomatoes cv. Rila F_1, early and standard tomatoes yield, modified granules.
Abbreviations: **PVA** - polyvinyl alcohol, **PVA - M** - modified polyvinyl alcohol.

INTRODUCTION

The traditional methods of nitrogen nutrition in many cases lead to number of unfavorable on the environment phenomena. According to Koteva (2003) the long standing mineral fertilizing leads to increasing of soil acidity, destruction of soil structure and lower humus content, especially by using of ammonium nitrate. A part of ammonium nitrogen can not be assimilated, due to evaporation by decomposition of salt in the soil. According to European Environment Agency (2003) the presence of nitrates is a common problem for many European regions. In many cities groundwater are contaminated with nitrates. In regions with intensive agricultural activities, nitrate content is higher than the allowable 50 mg/l (12). According

to Revich (2000), the intensive feeding with nitrogen deteriorates the quality of plant production, related to changes in population health.

In recent decades, the Black Sea sapropelles are subject of special research, because of possibility for their application in various aspects of agriculture, related to soil fertility. Their origin according Dimitrov et al. (1988) have started 11 000 years ago, when the salt waters have passed to the Black Sea, after an ecological cataclysm. As a consequence the more from the available flora and fauna perished and formed about 2 meters sediments on the sea bottom (2,3) An important motive for studying of sapropelles according to Bmins (1994) in agreement with Dimitrov et al., (2000) is the favorable macro- and micro-componential composition of sapropelles. Georgiev (2005) has established that they improve the agrotechnical properties of soils and stimulate the growth of plants.

It is known that some water soluble and amphiphilic polymers swell in the presence of water, leading to forming of layer with membrane properties. It could be used for preparing of fertilizing granules covered with such polymers, to prolong diffusion of nutrient elements under the form of ions (4).

The aim of present work was to study the possibility of optimizing nitrogen nutrition by using of modified granules containing Black sea sapropelles and covered with water swelling polymers.

MATERIAL AND METHODS

1. Elemental analysis

Sample sapropelles was taken from a depth 1200 m in the area of Black Sea was analyzed for a content of K, P, Si , Ti , Al, Ca, Na., as well as some microelements, as Fe, Mn, Mg, Cr, Mo, Cu and heavy metals Zn, Ni, Pb. They were determined in the form of oxides. An inductively coupled emission spectrometry (Jobni Yvon Emission - JY 38 S. France) was used. The quantitative measuring was carried out with apparatus ICP.

2. Biochemical analysis

Humus content of sample Black Sea sapropelles was determined by methods of Turin (12). Content of total carbohydrates was established by the Bertrand and *Hagedorn-Jensen* methods.(6) For total acids content, calculated as malic acid was used methods of acidimetric titration with 0,1n NaOH.(6) Absolute dry matter was determined by weight method (Stanchev et all, 1972). The content of vitamin C in tomato fruit was determined by methods of Murray (1961).

3. Composition and preparing of modified granules

The granules were with size 8-10 mm, containing 440 g/kg ammonium nitrate, 300 g/kg Black sea sapropelles as amendment and 260 g/kg filler (kaolin). They were formed in Mechanization department at Plovdiv Agriculture University on a rotary plate granulator by spraying with water solutions of PVA in concentration 5 g/kg at variant (I) and PVA-M in concentration 5 g/kg at variant (II). PVA-M, represents acetylated with acetic anhydride PVA. The rate of acetylated OH-groups was 30%. After drying up, granules were covered additionally with polymeric layer by treatment with solution of the same polymers in concentration 50 g/kg.

4. Greenhouse experiment

A study was made on the tomatoes cv. “Rila” at plastic unheated greenhouse in the period 2005-2006. Soil type used was alluvial-meadow (Mollic Fluvisol) with pH 6,6. Humus content was 2,87 mg/kg, total nitrogen – 15,80 mg/kg, mobile phosphorus - 23,25 mg/100 g and mobile potassium - 44,8 mg/100 g soil. Fertilization of the experimental area with superphosphate was done last pre-treatment at a dose providing 18 kg /da active substance. Pricked in glasshouse tomato seedlings were planted in three variants - I, II and control, at three replications (3 x 8 plants). The planting was made at the end of March by block method in strip-line by scheme 90+60x35 cm. As nitrogen fertilizer was used ammonium nitrate. At the control variant the fertilizer was introduced threefold during the vegetation period at a dose 15 g per plant (61,5 kg/da) as follows: First nutrition was made a week after planting of seedlings, the second - at the start of the first fruit and the last – in the initial flushing of the first fruit. In variants (I) and II nitrogen fertilizer was introduced only ones in the form of modified granules, which composition is described above, at a dose 12 g per plant (49,2 kg/da), immediately before planting of seedlings. Tomato plants were formed to one stem. The vegetation peak was removed after forming of fifth raceme. During the vegetation period was applied the traditional for this production direction technology. For irrigation of plants was used drop irrigation system.

Object of study were indicators early and total standard yield of tomato fruits as well as content of vitamin C, absolute dry matter, sugars and total acids. The early yield was determined by the amount of fruit from the first three harvests – 10.06, 17.06 and 25.06. The total standard yield was determined by the amount of fruit from all eight harvests in the period 10.06-30.07.

The resulting data were processed mathematically by ANOVA program - Duncans multiple Rangetest (Steel, R. et al., 1980).

RESULTS AND DISCUSSION

The results from the elemental analysis of sapropelles are shown at tables 1,2. The content of macro- and microelements was established, calculated as oxides. The data show that for some important for the crops vegetation microelements, such as Cr, Mo, Mn, their content in sapropelles exceeds many times the same in soils. The

Table 1. Chemical composition. Content of humus and microelements

Sample oxides	Cr g/t	Mo g/t	Zn g/t	Mn g/t	Pb g/t	Cu g/t	Ni g/t	Humus g/kg
Sapropel	50.00	36.40	65.82	383.42	28.22	36.63	49.75	68,6

Table 2. Chemical composition. Content of macro- and microelements

Sample oxides	SiO_2 g/kg	TiO_2 g/kg	Al_2O_3 g/kg	FeO g/kg	MnO g/kg	MgO g/kg	CaO g/kg	Na_2O g/kg	K_2O g/kg	Loss by 1273 K g/kg
Sapro-pelles	397,6	7,0	116,9	45,7	0,4	26,8	154,6	21,3	1.83	199,7

Table 3. Early yield, of tomatoes, cv. "Rila" F_1 (kg/da) and average value for 2005-2006

№	Variants	2005	2006	Average value 2005-2006		
				kg/da	% to control	% to total yield
1	Control	1922	1871	1896	100	20,9
2	Variant I	2001	2065	2073	109,3	21,3
3	Variant II	2091	2024	2050	206,8	19,9
4	GD 5%	71,8	92,3			
5	GD 1%	102,5	138,4			
6	GD 0,1%	158,9	205,0			

presence of CaO is 154,6 g/kg, which is over the limits in comparison to most soil types. Sapropelles contain K_2O – 1,83 g/kg, MgO – 26,8 g/kg, and some other elements which determine them as a natural micro- and macro fertilizer. The lost by heating at 1273 K, (table 2) was 199,7 g/kg, because of organic matter and carbonates. Humus content is an important factor for the soil fertility, because it improves the nitrogen assimilation from the plants. (5) Sample used sapropelles contains 68,6 g/kg humus (table1). The content of heavy metals Zn, Ni, Pb is in admissible borders.

The use of granules coated with polymer membrane has a significant impact on economic productivity of tomato plants. This effect was less pronounced in the early yield of fruit (table 3). The increase compared to control is within 6.8% -9.3% as reported differences by years of good and very good statistical reliability. Data from table 3 show no significant change in the proportion of early yield compared to the total standard yield. Quantity, obtained from three harvest standard production varies between 19.9% and 21.3% of total amount harvested by the end of the harvest period.

Reliable method to include scheduled nitrogen fertilizer in granules coated with polymer membrane significantly increase the total amount of the resulting standard yield (table 4). Highest results in years and average for the two-year period were obtained in variant II, in which the percentage expressing the difference, compared to control reached value 14,3%. The impact is less pronounced in variant (I), but in its differences with the control in the first and second year were very good and well warranted. Analysis of results and the fact that despite the smaller quantity of fertilizer inputs, were obtained higher yields, give rise to claim that modified granules provide more effective assimilation of ammonium and nitrate nitrogen, which is an important factor for growth in all plant organs, including fruit. Formation of polymer membrane after swelling of polymer coating, due to soil moisture, may result in more even and prolonged releasing and assimilation of ammonium and nitrate nitrogen in the soil nutrient solution. It reduces losses, due to decomposition of ammonium nitrate, associated with separation and departure of ammonia, as well as washing and removal of nitrate nitrogen in groundwater. Improved mineral nutrition of plants determines the highest yield of fruit. This hypothesis was confirmed by the fact that the highest yield was obtained at variant II. In this case the used modified granules possess polymer coating with PVA-M, possessing amphiphilic

Table 4. Total standard yield of tomatoes cv. Rila and average yield for 2005-2006

№	Variants	2005	2006	Average yield (2005-2006)	
				kg/da	%
1	Control	8933	9194	9058	100
2	Variant I	9768	9660	9714	107,2
3	Variant II	10148	10552	10350	114,3
4	GD 5%	82	287		
5	GD 1%	123	415		
6	GD 0,1%	184	625		

Table 5. Biochemical characteristic of tomato fruit. Average value for a period 2005-2006

№	Variants	Absolute dry matter, %	Total carbo-hydrates (%)	Total acids (%)	Vitamin C mg/%
1	Control	4,93	2,49	0,69	18,2
2	Variant I	5,03	2,41	0,62	19,1
3	Variant II	5,08	2,49	0,61	19,4

character - limited water solubility. This is a prerequisite for more longer diffuses of nitrogen, associated with its more effective assimilation by plants. Should take into account the presence of marine sapropelles. It is reasonable to assume that partly the reported biological effect was due to additional introduction of macro-, microelements and organic matter in soil medium.

The results in table 5 show that the introduction of modified nitrogen granules in variants I, II does not substantially alter the biochemical characteristics of fruits.

CONCLUSIONS

1. Fertilization by modified granulates, containing ammonium nitrate, sapropelles and water swelling polymers offers qualified new opportunities to improve nitrogen nutrition in tomato plants, cultivated in greenhouse conditions.
2. The application of modified granules has significant economical effect, manifested in increased early and total standard yield by 6.8% to 9,3% and 7,2% to 14,3%, by reduced nitrogen fertilizer dose with 20%.
3. The tested method of nutrition is recommended to sensitive of nitrates vegetable crops, because of regulating entry of nitrogen. Expected is realizing of ecological effect, due to decreased pollution of plant production and groundwater.

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Рецензент – доц. д-р Николай Панайотов
E-mail: nikpan@au-plovdiv.bg