

**РЕЗЮМЕТА**  
**на научните публикации**  
**на гл. ас. д-р Иванка Иванова Тринговска-Мендева**

Mihov M. and Tringovska, I. (2010). Energy Efficiency Improvement of Greenhouse Tomato Production by Applying New Biofertilizers. *Bulgarian Journal of Agricultural Sciences*, 16 (4), 454-458. IF 0.153

**Abstract:** Greenhouse tomato production in Bulgaria is extremely energy intensive; therefore the majority of producers grow tomatoes in greenhouses without heating. The aim of the research was to improve the tomato production energy effectiveness by using new technology conventional fertilization based on soil analysis and novel biofertilizers instead of manure. Two biofertilizers were used: bacterial fertilizer BioLife (USA) and mycorrhizal inoculum Media Mix (USA). The application of biofertilizers to improve soil fertility combined with optimized use of synthetic fertilizers can increase the energy output with the yield which

leads to an increased energy output-input ratio to 1.19 and 1.11 respectively. The energy output with the yield exceeds the energy inputs and energy gains of 19.45 GJ.ha<sup>-1</sup> and 11.40 GJ.ha<sup>-1</sup> are achieved. The results show that the total energy output (90.52 GJ.ha<sup>-1</sup>) increased by 32.0% when BioLife was used and by 22.9% when Media Mix was used. Bacterial fertilizer, mycorrhizal inoculum and tomato fruits energy equivalents of 0.01 MJ.kg<sup>-1</sup>, 14.5 MJ.kg<sup>-1</sup> and 1.2 MJ.kg<sup>-1</sup> respectively have been established to allow an energy assessment of tomato production.

**Key words:** energy, energy productivity, tomato, greenhouses, mycorrhiza.

Kostov R., Tringovska I., Protochristov, H. (2013). Geochemistry of the Cretaceous-Tertiary (K/T) Boundary Clay Layer in the Byala Region (Black Sea Shore, Bulgaria). *Comptes rendus de l'Académie bulgare des Sciences*, 66 (12), 1717-1724. IF 0.214

**Abstract:** Presented and discussed are inductively coupled plasma optical emission spectrometry (ICP-OES) data on the geochemistry of Cretaceous-Tertiary (K/T) boundary clay samples from sections on the Black Sea coast near the town of Byala, which have been previously studied from a stratigraphical, mineralogical, geochemical, sedimentological and paleontological point of view. The distribution of certain elements as Cr, Co and Ni are supposed to correlate with Ir, which is with high values in such

boundary clays (iridium anomaly). A correlation is also observed with the colour of the boundary clays - black, gray and brown clays have higher Cr and Fe content. The geochemical data fingerprinting is important for detailed local interpretation of the genesis of the Cretaceous-Tertiary (K/T) boundary profiles in this and other Bulgarian sites in comparison with similar K/T sites worldwide.

**Key words:** Cretaceous-Tertiary (K/T) boundary, clay layer, geochemistry, Byala, Bulgaria.

Grozeva, S., Atanasova, A., Denev, P., Ganeva, D., Kratchanova, M., Tringovska, I. (2013). Polyphenolic constituents, antioxidant activity and mineral content of very small and small fruited tomato (*Solanum lycopersicum* L.) genotypes. *Agrochimica*, 57 (4), 337-347. IF 0.314

**Summary:** In the present study seven breeding lines of tomato were analysed for major polyphenolic constituents, antioxidant activity and mineral content. These lines were a result of interspecific hybridization with wild relatives and represented very small (cherry) and small-fruited tomato. In the group of cherry tomatoes the highest amounts of total polyphenols (933.3 mg GAE kg<sup>-1</sup> fresh weight (FW)), chlorogenic acid (84.4 mg kg<sup>-1</sup> FW) and minerals were detected in line 1620/10. This genotype also had a high concentration of rutin (66.1 mg kg<sup>-1</sup> FW), which correlated with the highest antioxidant activity

measured by Oxygen Radical Absorbance Capacity (ORAC) and Hydroxyl Radical Antioxidant Capacity (HORAC) methods. In the group of small-type tomatoes, lines 1203/06 and XXIV-a were distinguished by the highest content of polyphenols. The investigated breeding lines, especially 1620/10, 1203/06 and XXIV-a, are potentially useful in tomato breeding programmes for the development of new varieties with improved composition and higher antioxidant activity.

**Keywords:** HORAC, micro and macro nutrients, ORAC, rutin, tomato.

Atanasova, A., Denev, P., Tringovska, I., Grozeva, S., Ganeva, D., Kratchanova, M., Panchev I. (2014). Optimization of the key parameters for extraction of polyphenol compounds from tomato fruits (*Solanum lycopersicum* L.). Kinetics of the process. *Bulgarian Chemical Communications*, 46, Special Issue A, 65-70. IF (2013) 0.349

**Abstract:** The main parameters that affect extraction process of polyphenolic compounds from tomato were investigated. The most suitable solvent for reaching maximum yield of polyphenols was acetone-water mixture 80:20 (v:v). Using this extractant the concentration of extracted polyphenols was approximately 17% higher than using ethanol and methanol. The optimal extraction time, temperature and solid to solvent ratio were 45 min, 60°C and 1:40, respectively. Using these extraction parameters the yield of total

polyphenols in tomato variety Desperado was 27.80 GAE/100 g fresh weight. The kinetics of extraction process was investigated and theoretical model describing extraction process was proposed. This mathematical model provides the theoretical initial amount of polyphenols in tomato fruits which could be useful for the breeding programs of varieties with high amount of polyphenol compounds.

**Key words:** tomatoes, polyphenols, extraction, optimization, kinetics.

Tringovska, I., Dincheva T., Ivanova, I. (2014) Effect of the genotype, vermicompost type and dosage on tomato growth and nutrient uptake at nursery stage. *International Journal of Agriculture Innovations and Research* 3 (3), 761-769. IF 1.123

**Abstract:** The aim of this work was to evaluate (i) the effect of the type of vermicompost and (ii) the effect of the dosage of vermicompost on nutrient status and growth characteristics of tomato transplants; (iii) the variety response of tomato to vermicompost type and dose. The experiment was conducted in a greenhouse at Maritsa Vegetable Crops Research Institute, Bulgaria. The results revealed that synthetic fertilizers could be fully replaced by the vermicompost and there was no specific variety response to the treatments. The optimal dose for

growing of tomato transplants is 25% from the volume of the potting mixture for two of the vermicomposts tested – Biohumus CM and Biohumus MM, while optimal dose of Lumbrical is 10% from the potting mixture volume. The results presented here constitute a new proof of feasibility of vermicompost as potting media constituent in sustainable culture practices and specifically in organic production.

**Keywords:** Cluster Analysis, Potting Mixtures, *Solanum lycopersicum* L., Transplants, Worm Castings.

Tringovska, I., Yankova, V., Markova, D., Mihov, M. (2015). Effect of companion plants on tomato greenhouse production. *Scientia Horticulturae* 186, 31-37. IF 1.504

**Abstract:** The objective of this study was to assess the effect of companion plants as marigold (*Tagetes patula* L.), basil (*Ocimum basilicum* L.), lettuce (*Lactuca sativa* L.) and white mustard (*Sinapis alba* L.) on (i) greenhouse tomato yield and fruit quality; (ii) root-knot nematodes infestation and (iii) energy effectiveness of tomato production. The experiment was carried out during three consecutive years (2011–2013) in an unheated greenhouse. White mustard caused significant decrease in early and total yield of tomatoes as well as decreased the average fruit weight. Marigold, basil and lettuce did not decrease significantly the tomato productivity. Chemical parameters of tomato fruit quality, including antioxidants content, measured twice in a harvest period, were positively affected by the intercrop systems in most cases.

Although all tested companion plants suppressed to some extent the development of *Meloidogyne* spp., the whitemustard and marigold were the most promising ones having effectiveness of 53.45% and 46.38% against the root-knot nematode invasion. The control treatment had the highest energy intensity (1.43 MJ kg<sup>-1</sup>), mostly due to the costs for manual weed control. The manual operations for weed control in intercropping systems decreased three times. The lowest energy intensity (1.03 MJ kg<sup>-1</sup>) was established for marigold as companion plant of tomato. Based on the obtained results white mustard and marigold could be considered as most promising companion crops in greenhouse tomato production.

**Keywords:** Energy productivity, *Lactuca sativa* L., *Meloidogyne* spp., *Ocimum basilicum* L., *Sinapis alba* L., *Tagetes patula* L.

Masheva S., Yankova V., Tringovska, I., Kanazirska, V. (2008). Application of some bioproducts for improvement and protection of greenhouse tomato from soil pests. *Acta Horticulturae*, 807, 765-770.

**Abstract:** An experiment with tomato variety Belle F1 was carried out during the period 2006 - 2007 in Venlo type unheated greenhouse at the Maritsa Vegetable Crops Research Institute, Plovdiv. Plants were grown in 1:1 peat:perlite (v/v). The effect both of the bioproducts and of pesticides on the plant protection against to the soil pathogens and root-knot nematode (*Meloidogyne arenaria*) that were infested artificially to substrate was studied. The tested treatments were bioproducts namely Trihodermin (mycelium of the *Trichoderma* spp. fungus-antagonist) and BioAkt WG (a.i. *Paecilomyces lilacinus* spores, strain 251), the pesticides namely Topsin M (a.i. thiophanate-methyl) and Vydate 10

G (a.i. oxamyl) and the Lumbrical vermicompost. It was established that in pathogen presence, the studied plant protection products have an inhibiting effect on root-knot formation (Vydate 10 G, BioAkt WG, Lumbrical) as well as on the soil pathogen attack (Trihodermin, BioAkt WG). An improvement of the growth and reproductive plant manifestations and yield increase was observed. The bioproducts Trihodermin and BioAkt WG, and the Lumbrical vermicompost could be used as an ecological solution for plant protection against the soil pests.

**Keywords:** hydroponics crop, bioproducts, pesticides, soil pathogens, root-knot formation, index of infestation.

Antonova G., Dimov I., Dintcheva Tz., Boteva Hr., Masheva St., Yankova V., Kanazirska V., Pevicharova G., Tringovska I., Michov M., Georgieva O. (2010). Evaluation of the stability and the adaptability on the yield of broccoli cultivars grown under condition in monoculture and intercropping system. *Cruciferae Newsletter*, 29, 16-18.

**Abstract:** The present study was made with the purpose of evaluating the stability and adaptability of the production from the central flower heads of five broccoli hybrids tested in two cultivation systems - as monoculture and in intercropping system growing together with tomatoes and pepper. It was established that the hybrids broccoli 'Coronado F1' and 'Kermit F1' showed good productivity 7.430÷8.800 t/ha and stability ( $bi < 1$ ) expressed in both of cultivation system and the abilities for adaptation was good. In monoculture system for 'Shadow F1' was read high yield 9.730

t/ha but in the intercropping system the productivity was significant lower 6.500 t/ha. In both systems the genotype showed low stability ( $bi > 1$ ). The genotype was demonstrated good adaptability in self-cropping system but the abilities for adaptation in intercropping system was poor. The hybrids 'Belstar F1' and 'Lucky F1' independence of the kind of cultivation systems were lower productively 6.000÷6.430 t/ha and unstable ( $bi > 1$ ) with poor abilities for adaptation.

**Keywords:** broccoli, yield, stability, adaptability, monoculture, intercropping system.

Tringovska, I. (2012). The Effects of Humic and Bio-fertilizers on Growth and Yield of Greenhouse Tomatoes. *Acta Horticulturae*, 960, 443-447.

**Abstract:** Optimization of growth, yield and quality of vegetable crops in an integrated manner is achievable through efficient use of organic, inorganic and biological sources of nutrients. The present study aimed to evaluate the effect of foliar or soil application of humic and bio-fertilizers, on the growth and yield of greenhouse tomatoes. The experiment was carried out during three consecutive years in an unheated greenhouse at Maritsa Vegetable Crops Research Institute, Bulgaria. A commercially available humic fertilizer, produced from vermicompost, and biofertilizer, containing *Lactobacillus casei*, *Lactobacillus lactis*, *Phodopseudomonas palustris*, *Saccharomices cerevisiae* were tested. Soil application of both fertilizers was performed only once, a week after transplanting, while the foliar application was conducted three times with 10-14 day intervals after transplanting. In order to assure uniform background of the experimental

plots, the soil was supplemented with mineral fertilizers according to the recommendations following the soil analysis. The results indicated that soil application of both fertilizers stimulated the growth of tomato plants. The total tomato yield was increased with 19 and 21% after soil application and by 13 and 14% after foliar application of bio-fertilizer and humic fertilizer, respectively. The enhancement of the total yield was attributed to the enhancement of the mean fruit weight, which increased by 14-30 g per fruit. The early yield and the number of fruits per plant were not influenced by the applied humic or bio-fertilizers. The results indicated that the utilization of bio-fertilizer or humic fertilizer in fertilization practices can lead to higher yield of greenhouse tomato with improved market quality.

**Keywords:** *Solanum lycopersicum* L., plant nursery, peat substrate, cow manure, worm castings.

Dintcheva, T., Tringovska, I. (2012). Growth Response of Tomato Transplants to Different Amounts of Vermicompost in the Potting Media. *Acta Horticulturae*, 960, 195-201.

**Abstract:** The application of vermicompost as substrate amendment could benefit the vegetable transplants production and provide a sustainable nutrient management approach for the improvement of plant's growth. The objective of this study was to investigate the effect of increasing amounts of cow-horse manure vermicompost on the growth and the nutrition of tomato transplants. Tomato transplants were grown in 0.5 L of peat moss and perlite mixture at 1:1 (v/v) ratio, in which the vermicompost constitutes 10 to 50% of the mixture's volume. Some growth characteristics as well as some physicochemical and chemical properties of the vermicompost-

amended potting mixtures were investigated. The results indicated that utilization of 10 to 50% vermicompost stimulated the growth of tomato plants. The positive effect of the vermicompost on plant growth increased parallel with the increase of its content in the substrate volume. An increase of up to 3.7-fold was observed in shoot fresh weight, up to 2.6-fold increase in shoot length, up to 62% increase in leaf area, and up to 28% increase in number of leaves when vermicompost constituted 10-50% of the mixture volume, compared to the control (peat moss and perlite mixture without vermicompost). Moderate to strong correlations were established between N and K in potting

mixtures and in plant tissues, suggesting that vermicompost contributes considerably to the supply of the plant with these nutrients. Consequently, the cow-horse manure vermicompost

should be taken into consideration as a potential peat substitute in nurseries.

**Keywords:** *Solanum lycopersicum* L., plant nursery, peat substrate, cow manure, worm castings.

Pasev, G., Tringovska, I., Kostova, D., Dintcheva, T. and Radeva, V. (2012). Effect of Vermicomposts on Tomato Transplants Response Against Tomato Mosaic Virus (ToMV). *Acta Horticulturae*, 960, 333-340.

**Abstract:** One of the most important keys to successful vegetable crops is the production of high quality transplants. The choice of growing media is considered one of the largest challenges. Nutritional quality, structure and stability of the substrate are of primary importance. Vermicomposts have proved to be very promising as substrate amendments in transplants production. Utilization of good vermicomposts stimulates plant growth, as well as it has some suppressive effect on plant diseases. *Tomato mosaic virus* (ToMV) is one of the most dangerous pathogen on tomato, readily transmitted mechanically by human activities, especially during production of tomato transplants.

The aim of the current study was to assess the ability of different vermicomposts, produced in Bulgaria, to influence on the tomato transplants defense reaction against ToMV. Tomato transplants were grown in potting mixtures, amended with two different vermicomposts (Lumbrical and Biohumus), utilized in 25, 50, 75 and 100% ratio. The control variants were transplants, grown in potting mixtures

without vermicomposts as additives. Virus inoculation was performed at cotyledon stage. The stem length, leaves number and shoot fresh weight of the transplants were considered as criteria to establish the vermicomposts' influence on tomato transplants defense against ToMV. Biological assay on TMV local lesion host and ELISA were used to establish the virus concentration in different treatments. The obtained data supported the positive effect of vermicomposts on transplants' vegetative growth, regardless the systemic spread of the virus. Biological assay and ELISA established significantly lower virus concentration in vermicomposts treatments compared with those in controls. The two tested vermicomposts differed in their ability to improve the tomato transplants defense reaction against ToMV. The best results, supported by all indicators, were received in treatments with utilization of Biohumus, in ratios above 50%.

**Keywords:** *Solanum lycopersicum* L., plant viruses, plant nursery, worm castings, ELISA

Tringovska, I., Kostova, D., Masheva, S., Yankova, V. and Pasev, G. (2012). Preliminary Screening of Indigenous Bacterial Isolates from Soil and Fish Pond Sediments for Their Beneficial Effect on Vegetables Growth and Health. *Acta Horticulturae*, 938, 355-362.

**Abstract:** Plants interaction with beneficial microorganisms could result

in a significant growth response and also could increase the host tolerance to

pathogens. In search of efficient for vegetables growing Plant Growth Promoting Rhizobacterial (PGPR) strains a number of isolates were separated from different soils and fish-pond sediments in Bulgaria. These isolates were screened initially *in vitro* for some plant growth promoting traits like production of siderophores, phosphate solubilization and antimicrobial activity. Pot experiments in growing chambers were carried out with some of the best performed after *in vitro* tests isolates, aiming further to screen their ability to improve plant growth as well as to improve the level of resistance against several economically important pests on tomato and cucumber. Seeds or plant's roots were treated with bacterial suspensions. The plants were grown in sterile perlite or non-sterile mixture peat:perlite, supplemented with nutrient solution. Plant growth promotion was assessed by fresh shoot weight, while the efficacy against *Cucumber mosaic virus* (CMV) was assessed by index of depression, based on biometric data, and

serologically by indirect ELISA; against *Meloidogyne* spp. – by root galling index and some biometric data; against *Fusarium oxysporum* f.sp.*radicis cucumerinum* and *Pythium* spp. – by index of infestation and biometric data. After screening of more than hundred isolates a few were selected for their multiply beneficial functions as positive influence on plant growth and health. In a time course study several isolates were selected for their ability to reduce disease severity and viral titer of CMV on susceptible cucumber cultivar. Some of the selected isolates confirmed their positive effects also against *Meloidogyne* spp., *Fusarium oxysporum* f. sp. *radicis cucumerinum* and *Pythium* spp. Further evaluation of the isolates exhibiting beneficial effect is needed to uncover their efficacy as PGPR that could be used in horticulture as lowinput and multifunctional agents.

**Keywords:** beneficial bacteria, tomato, cucumber, *Cucumber mosaic virus* (CMV), *Meloidogyne* spp., *Fusarium oxysporum*, *Pythium* spp.

Tringovska, I. and Dintcheva, T. (2012). Vermicompost as Substrate Amendment for Tomato Transplant Production. *Sustainable Agriculture Research*, 1 (2), 115-122.

**Abstract:** Vermicompost may be a promising substitute for peat especially in transplant production. Vermicomposting is a sustainable solution for management of organic wastes. However, due to variability of organic wastes, vermicomposts might have varying nutrient content levels. The study compared vermicomposts from different sources on growth and nutrition of tomato (*Solanum lycopersicum* L.) transplants. Chemical composition of vermicomposts differed. Common characteristics were high pH

and very high electrical conductivity. All vermicomposts stimulated growth of tomato transplants, with up to a 2.2-fold increase occurring in shoot biomass. Differences in growth were attributed mainly to differences in nutrient content of the potting mixtures, but some changes in physical and biological properties of the substrate could also be responsible.

**Keywords:** *Solanum lycopersicum*, Bulgaria, cow manure, plant nursery, vermicompost.

Masheva, S., Tringovska, I., Lazarova, T. and Ganeva, D. (2014). Possibilities for control of corky root (*Pyrenochaeta lycopersici* Schn., Gerl.) in tomato grown in cultivation facilities. *Turkish Journal of Agricultural and Natural Sciences*, Special Issue 2, 1702-1706.

**Abstract:** A study for establishment of the effect of variety and fertilization on the index of infestation by corky root (*Pyrenochaeta lycopersici* Schn., Gerl.) in tomato plants grown in cultivation facilities was carried out. The experiment was performed in the conditions of natural infestation with 14 tomato varieties and lines at three systems of fertilization – mineral, integrated and organic. Effective microorganisms (EM) were applied additionally in the variants with integrated and organic production. The studied varieties were divided in four

groups depending on the susceptibility to the agent of corky root: with index of infestation up to 20%; from 21 to 40%; from 41 to 60% and over 61%. The lowest index of infestation is recorded in the variants with integrated and organic production including the application of vermicompost, rock phosphate and EM. The yield recorded in this variant was lower compared to the variant with mineral fertilization but the differences were not mathematically significant.

**Keywords:** *Pyrenochaeta lycopersici*, tomato variety, vermicompost, effective microorganisms, yield.

Nikolov, N., Tringovska, I. (2014). Preparation of peat for substrates by neutralization with black sea organic-mineral sediments – sapropels. *Turkish Journal of Agricultural and Natural Sciences*, Special Issue 1, 603-607.

**Abstract:** Peat is a ground component in various substrates for seedling production. Because of content of organic acids in the peat it has to be neutralized before using. In the period May-June 2014 was carried out neutralization of peat from Lituania, using Black sea organo-mineral sediments – sapropels. The results obtained were compared to control – peat without sapropels and etalon – neutralized with powdered calcium carbonate peat. Incorporated in the peat the marine sapropels increase pH values as follows: At an amount 10 g/kg from pH 3.76 (control) to 4.85 at the first day, 5.24 after four days incubation, 5.41 after 11 days and 5.47 after 28 days. At an amount 30 g/kg at the same incubation periods to pH 4.92, 5.49, 5.77

and 5.93. At an amount 50 g/kg respectively to pH 6.37, 6.42, 6.47 and 6.58. At an amount 70 g/kg respectively to pH 6.90, 7.01, 7.18 and 7.23. At an amount 100 g/kg respectively to pH 7.08, 7.15, 7.19 and 7.28. By using calcium carbonate as etalon pH changes as follows: At an amount 10 g/kg from pH 3.76 (control) to 5.13 at the first day, to 5.33 after four days incubation, 5.42 after 11 days and 5.45 after 28 days. At an amount 50 g/kg respectively to pH 7.23, 7.27, 7.33 and 7.39. At an amount 100 g/kg respectively to pH 7.32, 7.41, 7.43 and 7.56, compared to control (pH 3.76).

**Key words:** marine sapropels, marble powder, peat moss, electrical conductivity, calcium, magnesium.

Georgieva, D., Tringovska, I., Atanasova, A. and Kmetov V. (2014). Analytical features of HPLC method for hydroxycinnamic acids and flavonoids analysis in tomato fruits. *Agricultural science and technology*, 6 (4), 480-485.

**Abstract:** Quality control of analytical procedure is required for any amended or new method to ensure its applicability and capability to produce reliable results. This study shows an optimized method for high performance liquid chromatography (HPLC) analysis of some polyphenolic acids and flavonoids in tomato fruits. Efficient separation of chlorogenic acid, caffeic acid, p-coumaric acid, ferulic acid, rutin, myricetin, naringenin and quercetin was achieved on Poroshell 120 reverse-phase column C (75 mm x 4.6 mm x 2.7 µm) by gradient elution with mobile phase A (0.5% Acetic Acid), mobile phase B (1:1 mix of 0.5% Acetic acid and Acetonitrile) and mobile phase C (Acetonitrile). Some analytical features of the method such as limit of detection (LOD), limit of quantification (LOQ),

linearity and precision were estimated after testing of an eight-compound mixture of the single reference phenolic compounds at seven concentrations. It was found that LOQ is from 0.02 to 0.63 ppm, for the included analytes with linear quantitative response up to 10 ppm. The method precision was estimated as measurement repeatability and intra-laboratory reproducibility. The relative standard deviation (RSD) obtained after analyzing 3 replicates and 7 concentrations varied from 0.1 to 12.6%. These results suggest that the optimized method has a good potential for simultaneous quantification of the above mentioned hydroxycinnamic acids and flavonoids in tomato fruits.

**Keywords:** limit of detection, limit of quantification, precision, tomato fruits, polyphenols.

Tringovska, I, Naydenov, M, Valcheva, I and Dintcheva, T. (2014). Effect of indigenous bacterial isolates on development of tomato plants grown under phosphorus deficiency. *Acta Horticulturae* (под печат).

**Abstract.** Soil microorganisms play an important role in plant growth and nutrition improving agriculture sustainability. The aim of the current study was to assess the effect of indigenous bacterial isolates inoculated in tomato seeds on plant growth under conditions of insufficient phosphorus in the growing substrate. Twelve bacterial strains, isolated onto nitrogen-free media, were used to inoculate germinated tomato seeds. Plants were grown in a growth chamber on perlite, supplemented with rock-phosphate as a sole source of phosphorus. Modified Hoagland's nutrient solution (without

phosphorus (P)) was used for irrigation. An increase of 68 to 91% of the shoot fresh mass was recorded in seven treatments (with isolates Az1, Az7–Az12). Average 1.5 to 2.7-fold increase of shoot dry mass was recorded for all the tested bacterial isolates compared to the non-inoculated control. Evidences for increased availability of P were observed in Az1, Az6 and Az9 treatments although they were not effective enough to alleviate the P-deficiency in the growing substrate.

**Keywords:** *Azotobacter* spp., phosphorus, N:P ratio, *Solanum lycopersicum* L.

Tringovska, I., Tonev, D., Damjanova, A., Grigorov, T., Gutev, N., Protohristov, H. and Kovachev, N. (2014). Radiological and Microanalytical Study of Melnik Fine Wine. *Acta Horticulturae* (под печат).

**Abstract:** Radiological and chemical fingerprinting can help to determine the year of production - vintage and the geographical provenance or designation of origin of high quality wines. Radiological and chemical investigations are performed on Bulgarian Melnik fine wine, as well as, on vineyard soil, grape stems and grape leaves. The gamma-ray activity of the radioisotope Caesium-137 has been measured in wines from different vintages using Low-Background High-Resolution Gamma-Spectrometry. The specific concentrations of 16 metals have been

measured in samples from soil, grape stems, grape leaves and fine wine from Shiroka Melnishka variety grown in typical Melnik vineyard by means of Inductively Coupled Plasma-Optical Emission Spectrometry (ICP-OES). Radiological and chemical correlations obtained can be used as initial data base for determination of vintage back to 1986 and for eventual proof of designation of origin of Melnik fine wine.

**Keywords:** Broad-Leaved Melnik grape, Wine, Gamma-spectroscopy, Cesium-137, ICP-OES elemental analysis.

Михов М., Тринговска, И., Митова Т. (2008). Възможности за подобряване на енергийния баланс при производството на домати в стоманено-стъклени оранжерии чрез въвеждане на нови стратегии за поддържане на хранителния режим. *Селскостопанска техника*, 4, 2-7.

**Abstract:** The greenhouse tomato production is extremely energy intensive with the energy inputs for 1 kg tomato being 1.58 MJ. Decreasing the energy inputs for soil fertilization by applying new strategies for plant nutrition is one of the methods for improving the production energy effectiveness.

The results from the research show that by applying conventional fertilization based on soil analysis and novel biofertilizers instead of manure, the tomato yield can be increased by

31.50% when using Lumbrical and by 22.90% when using Mycorrhizal inoculums. Hence the total energy consumption could be reduced by respectively 16.75% and 31.75%.

The resulting reduction in the total energy input for fertilization and increase in the energy output with the yield lead to an increased energy output-input ratio to 0.80 and 0.91 respectively.

**Key words:** energy consumption, energy intensity, tomato production, greenhouses, nutrition, biofertilizers.

Атанасова, А., Денев, П., Тринговска, И., Грозева, С., Ганева, Д. (2013). Антиоксидантна активност и полифенолен състав на български сортове домати. *Наука Диететика*, 3, 24-27.

**Резюме:** Изследването е проведено с четири сорта домати, предназначени за свежа консумация, отличаващи се

по маса и цвят на плода. Сортове „Идеал“, „Наслада“ и „Розалина роса“ се отнасят към групата на едрите

домати с маса от 101 до 200 g, докато сорт „Розов блян“ е много едър с маса на плода над 200 g. Най-високо съдържание на общи полифеноли (61.34 mg/100 g) и рутин (3.20 mg/100 g) е установено в плодовете на сорт „Идеал“. Този сорт се отличава и с най-висока антиоксидантна активност, измерена и по двата използвани метода (9.7  $\mu\text{mol TE/g}$  за ORAC и 5.14  $\mu\text{mol GAE/g}$  за HORAC). Установена е добра корелация между съдържанието на общи полифеноли и

антиоксидантната активност на изследваните плодове ( $R^2=0.966$  за ORAC и  $R^2=0.887$  за HORAC). Направеното проучване показва, че сорт „Идеал“ може да бъде отличен като богат източник на полифенолни антиоксиданти и присъствието му в ежедневната диета може да има благоприятен ефект при превенция на заболявания, свързани с оксидативен стрес.

**Ключови думи:** домати, полифеноли, ORAC, HORAC, антиоксиданти

Атанасова, А., Тринговска, И., Денев, П., Ганева, Д., Грозева, С., Крачанова, М. (2013). Съдържание на полифеноли и антиоксидантна активност на домати, отглеждани при оранжерийни и полски условия. *Science & Technologies, Plant studies III* (6), 81-85.

**Abstract:** The purpose of this study was to determine the content of total polyphenols, rutin, chlorogenic acid and antioxidant activity in fruits of tomato, grown under greenhouse and field conditions. Experimental work was carried out in 2012 with two tomato varieties, Alya and Plovdivska karotina, created at Maritsa VCRI, Plovdiv. The amount of total polyphenols was 20-46% higher in field grown tomatoes than the same varieties, grown in greenhouse conditions. A similar tendency was observed in the content of rutin and antioxidant activity measured

by the *Oxygen Radical Absorbance Capacity* (ORAC) and *Hydroxyl Radical Averting Capacity* (HORAC). Therefore, it can be concluded that tomatoes, grown under field conditions have higher content of polyphenols and greater antioxidant activity, in comparison with the same varieties, grown in greenhouse. This proves that the growing conditions are one of the main factors determining the content of biologically active substances in fruits.

**Key words:** rutin, chlorogenic acid, HPLC, antioxidant activity.

Тринговска, И. (2015). Оптимизиране схемата на торене при оранжерийно производство на домати. *Растениевъдни науки, LII* (2): 101-105.

**Abstract:** The aim of the current study was to evaluate the effect of three fertilization schedules on nutritional status and yield of greenhouse tomatoes. The experiment was carried out in unheated greenhouse at Maritsa Vegetable Crops Research Institute. Three fertilization schedules were

compared: Schedule 1 in which plants received equal amounts N and K as radicular feeding, Schedule 2 in which plants received N, P and K as radicular feeding in changing amounts depending on plant needs and Schedule 3 in which radicular feeding was combined with foliar one, but plants received the same

total amount of nutrients as in Schedule 2. The combined radicular and foliar feeding increased the content of nitrogen, phosphorus, potassium and microelements in tomato leaves; stimulated plant growth; increased the early yield by 35 – 38% and the total

yield by 20 – 24% and increased fruit number per plant by 3 – 5 fruits. The application of Schedule 3 did not change the biochemical indexes of fruit quality.  
**Key words:** tomato, foliar feeding, yield, fruit quality.

Tringovska I. and Pevicharova G. (2009). Evaluation of Dutch tomato hybrids for greenhouse cultivation in Bulgaria. *Proceedings of the Second International Conference Research people and actual tasks on multidisciplinary sciences*, 1, 39-43.

**Abstract:** The study was conducted to provide basic information about overall yield and quality of some tomato hybrids for greenhouse cultivation. Plants were grown as soil culture in unheated glasshouse at Maritsa Vegetable Crops Research Institute, Plovdiv, Bulgaria. Five different hybrids (Belle, Amaral, Aegean, Velocity and Elpida) provided by Enza Zaden, the Netherlands were evaluated in relation to their growth, yield and fruit quality. The results from the experiment showed that all the tested hybrids are appropriate for greenhouse cultivation in Bulgaria during the spring season.

The plants from Amaral hybrid showed the fastest growth and high productivity. The total yield was the highest in Aegean (10058.2 kg/da), which fruits possessed the highest weight as well (144.8 g/fruit). Each variety presented its own specific characteristics regarding fruit quality. The highest values of brix and ascorbic acid content were observed in fruits from Velocity hybrid - 4.83% and 19.83 mg% respectively.  
**Key words:** *Solanum lycopersicum*, unheated glasshouse, yield, fruit quality, brix.

Георгиева, О., Тринговска, И. (2010). Результаты применения биопродуктов при производстве томата в оранжерийных условиях. Современные тенденции в селекции и семеноводстве овощных культур. Традиции и перспективы. II Международная научно-практическая конференция (2-4 августа 2010 года). Материалы докладов, сообщений. ВНИИССОК. – М.: Изд-во ВНИИССОК, 2010, Т2, 166-176.

**Резюме:** В оранжерейных условиях изучено влияние биопродуктов на увеличение урожайности и качество продукции томатов сорта Belle средне-раннего производства. Установлено, что почвенное внесение биопродуктов BioOne, Агрифула, Байкала ЭМ 1-У и Хумусила стимулирует темп нарастания растений, увеличивает общую продуктивность и выход

стандартной продукции томатов. Увеличение продукции томатов сорта Belle в результате применения биопродуктов варьирует между 12% и 35%, а количество нестандартных плодов не превышает 2% от общей продуктивности. Почвенное внесение биопродуктов Байкала ЭМ 1-У и Хумусила увеличивает микробиологическую активность почвы за счет увеличения количества

бактерий в ризосфере оранжерейных томатов и редуцирует развитие опробковения корней томата

(*Pyrenochaeta lycopersici* Gerlach. and Sch.) на зараженном участке.

Tringovska, I., Grozeva, S., Ganeva, D., Boteva, H., Atanasova, A., Pevicharova, G. and Mihov M. (2014). Yield and fruit quality of tomato varieties for different production systems. *Proceedings of X Jubilee National Scientific Conference with International Participation Ecology and Health* 5 June 2014 Plovdiv, Bulgaria, 105-110.

**Abstract:** The aim of the current study was to evaluate the yield and fruit quality of tomato varieties for greenhouse and field production. The experiments were carried out during the period 2012-2013 at Maritsa Vegetable Crops Research Institute – Plovdiv. Under greenhouse conditions five varieties were examined, while under open-field conditions – six large fruited determinate varieties for mid-summer production. In unheated greenhouse the highest total yields had Kiveli F<sub>1</sub> and Axiom F<sub>1</sub> (69.3 and 69.1 t ha<sup>-1</sup>, respectively). Kiveli F<sub>1</sub> was also distinguished with the highest early yield (26.1 t ha<sup>-1</sup>), followed by 34/11 F<sub>1</sub>. The highest content of vitamin C, total sugars, titrable organic acids, total polyphenols and dry matter were observed in IZK Alya, which is “Cherry” type, followed by variety Plovdivska karotina. These data suggested a reverse relationship between fruit yield and chemical parameters of fruit quality.

Among the studied varieties for mid-summer production Nikolina F<sub>1</sub> was assessed with the highest yield and fruit weight (69.0 t ha<sup>-1</sup> and 249.2 g, respectively). The content of polyphenols varied slightly (from 42.18 to 52.56 mgGAE 100g<sup>-1</sup> fresh weight), as the highest value was measured in the fruits of Divna F<sub>1</sub>. Comparatively higher content of total pigments and lycopene were registered in Kopnezh F<sub>1</sub> (10.93 and 9.12 g 100g<sup>-1</sup> fresh weight, respectively). Tiara F<sub>1</sub> had the highest content of vitamin C in the fruits (34.36 g 100g<sup>-1</sup> fresh weight). According to the analysis of the energy productivity the greenhouse grown Axiom F<sub>1</sub> and Kiveli F<sub>1</sub> and the field grown Nikolina F<sub>1</sub> and Kopnezh F<sub>1</sub> were distinguished with better values (0.60 kg MJ<sup>-1</sup> and 0.47 kg MJ<sup>-1</sup>, respectively).

**Key words:** *Solanum lycopersicum* L., fruit weight, vitamin „C”, polyphenols, energy productivity

Ботева, Х., Антонова, Г., Чолаков, Т., Тринговска, И., Начева, Е. (2014). Технологии за биологично производство на зеленчуци и картофи. *Сборник от Национална конференция с международно участие „Биологични растениевъдство, животновъдство и храни”*. Институт по планинско животновъдство и земеделие, Троян 27 - 28 ноември 2014 г.

**Abstract:** “Technologies for organic production of late head cabbage”, “Technology for biological production of leek” and “Biological production of tomato and cucumber seedlings” are elaborated on the basis of the performed

studies in the Maritsa VCRI, Plovdiv during the period 2006-2013. An appropriate variety composition, fertilization systems creating favourable conditions for higher and stable yields and increased resistance of plants to

unfavourable factors of the environment were established. Technological decisions for biological control of pests in field and greenhouse production are developed. It is made an assessment of

the economic and energy effectiveness in the biological production.

**Key words:** vegetables, potatoes, biological production, bioproducts, transplant.