Scientific Papers. Series B, Horticulture. Vol. LXIX, No. 2, 2025
Print ISSN 2285-5653, CD-ROM ISSN 2285-5661, Online ISSN 2286-1580, ISSN-L 2285-5653

INFLUENCE OF ORGANIC FERTILIZERS ON THE MORPHOLOGICAL DEVELOPMENT AND PRODUCTIVITY IN GREENHOUSE TOMATO

Roksana MINEVA

Trakia University, Agriculture Faculty, Studentski grad Stara Zagora, Stara Zagora, Bulgaria

Corresponding author email: mineva.roksana@gmail.com

Abstract

During the period 2022-2023 was studied, the morphological characteristics were monitored of a greenhouse tomato: plant height, number of leaves, number of inflorescences and number of buds per plant in different variants of treatment with organic fertilizers. The results of the morphological analysis show that in terms of plant height, the variants that were fed with organic fertilizers, on average for the studied period, exceed the unfertilized control by 12.2% to 18.5% for Vermilenza and by 14.3% to 23.6% for Grando. The application of fertilizers increases the development index in the studied tomato varieties. With application of the organic fertilizer Siapton, the highest values were recorded for the Grando variety - 10.50 and for the Vermilenza variety - 7.63. A strong positive relationship was established between the indicators `plant height` and `total yield`, with a correlation coefficient for the Grando variety r = 0.91, and for the Vermilenza variety r = 0.89. The nature of the linear relationship between the indicators `plant height` and `number of inflorescences` was determined, with a coefficient of determination R^2 = 0.846 for the Grando variety and R^2 = 0.797 for the Vermilenza variety.

Key words*: greenhouse tomato, organic fertilizers, productivity, ANOVA.*

INTRODUCTION

Tomato is among the most widely cultivated vegetable crops worldwide (Serio et al., 2006).
It is much appreciated due to its richness in health-promoting compounds such as minerals, carotenoids, vitamins, flavonoids, and polyphenols (Frusciante et al., 2007).
The tomato industry has been searching for new genotypes with improved fruit production, both in the field and industrially processed, together with high-quality performance under sustainable management conditions (De Sio et al., 2021).
Nowadays, using organic fertilizers is an efficient method to achieve sustainable agricultural development. The nutrient release rate of organic fertilizers is slow and hardly exceeds the absorption capacity of plants compared with chemical fertilizers (Guo et al., 2017).
Conventional fertilizers were considered vital for agricultural production to harvest high crop yields. Nevertheless, they are now deemed as environmentally hazardous and an obstacle to sustainable agroecosystems due to intensive chemical inputs that damage the soil over time and have long-lasting impacts (Khan et al., 2024).
The sustainability of agricultural systems is an important global issue. The application of organic fertilizers made from animal excreta or agricultural waste contributes to agricultural sustainability. The physical (structure and water retention capacity), chemical (nutrients and cation exchange capacity) and biological (microflora and microfauna) properties of a soil can be improved by the addition of organic matter (Whalen et al., 2000; Tejada et al., 2003). Long-term studies have shown that the application of organic matter improves crop yield and soil properties including water holding capacity, porosity, and water-stable aggregation and it decreases bulk density and surface crusting of the soil (Edwards et al., 1982; Schjonning et al., 1994).
Organic fertilizers can be of plant, animal or microorganism origin. Among organic fertilizers are composts (e.g., vermicompost, water hyacinth compost, village or town compost), farmyard manure (e.g., cattle and poultry manures), green manures (leguminous and non-leguminous plants) or biofertilizers (algal, fungal and bacterial). The advantages of organic fertilizers include improved physical, chemical, and biological soil properties, enhanced biological activity, slow release of

nutrients, improvement of organic matter, and reduced loss of nutrients. In addition to the benefits related to the environment, organic fertilization has also a positive impact on the quality of vegetable products and harvest quantity (Spencer et al., 2005)

The optimization of the water and fertilization regime in vegetable crops solves a number of problems related to increasing the efficiency of usable irrigation water, the water deficit and a number of environmental problems (Stoyanova et al., 2020). The use of adequate organic fertilization is necessary to promote organic crop production. Organic nutrient sources including compost, manure, compost extract, and authorized fertilizers could be combined and used in order to achieve a balanced nutrient supply and an improved organic tomato yield and quality. (Riahi et al., 2009).

Gao et al. (2023) reported that application of organic fertilizers enhances tomato productivity and fruit quality.

Foliar feeding with organic fertilizers combined with biological fertilization, stimulates vegetative plant activity (Kostadinov et al., 2019)

Organic fertilizers can influence plants growth due to their high nutrient content, high water holding capacity, plant growth regulators, and beneficial microorganisms (Ahmadpour et al., 2020).

MATERIALS AND METHODS

The objects of this study were two indeterminate hybrid greenhouse tomato varieties - Vermilenza F1 and Grando F1 - cultivated in an unheated polyethylene greenhouse near Plovdiv. The study was carried out during the period 2022-2023. The area is flat, with an altitude of 160 m and geographical coordinates N 42° 09', E 24°45' (GPS).

The two tomato varieties were planted under early production conditions, according to the following scheme 110 x 35 (single-row strip) in four replications. Planting was carried out on April 1 and harvested by July 10. The block method with a 10 m² harvest area was applied (Barov, 1982).

The tested varieties are:

VERMILENZA F1 - The fruits are 250-300 g in size. with a deep pink color. Does not crack and does not form a cob. Strong plant with a powerful root system, suitable for long production. Universal variety with excellent transportability. The variety is distinguished by high resistance to: Tomato mosaic virus, Fulvia fulva (Cladosporium fulvum), Verticillium albo-atrum, Verticillium dahliae, Fusarium oxysporum f. sp. lycopersici, Fusarium oxysporum f. sp. radicis-lycopersici. It has medium resistance to: Tomato spotted wilt virus, Tomato yellow leaf curl virus, Oidium neolycopersici, Meloidogyne arenaria, Meloidogyne incognita, Meloidogyne javanica.

GRANDO F1 - Large-fruited, indeterminate hybrid tomato, the fruits are flattened and shiny, with a deep red color, without a green ring, hard with a long storage period and resistant to transportation and with very good taste. The hybrid is not demanding on soil type, has a strong root system and high adaptive capacity. Average fruit weight 310-370 g. The hybrid is distinguished by high productivity and resistance to: Tomato mosaic virus, Verticillium albo-atrum, Fusarium oxysporum f.sp. lycopersici, Meloidogyne arenaria, Meloidogyne incognita, Meloidogyne javanica

The influence of the basic fertilization carried out with P_{23} (in the form of P_2O_5) and K_{25} (in the form of K_2SO_4) and feeding during vegetation with N_{50} (in the form of NH_4NO_3) and K_{66} (in the form of KNO_3) was studied. Basic fertilization was carried out with 50 kg/da P_2O_5 and 50 kg/da K_2SO_4. During the vegetation until the formation of the fruits, NH_4NO_3 was applied at a dose of 10 kg/da every 10 days. After the formation of the fruits, fertilization was carried out with NH_4NO_3 + K_2SO_4 at 8 kg/da.

The influence of foliar fertilization with amino acid- and carbon-rich fertilizers on the development and productivity of the two tomato varieties was studied, with fertilizers rich in amino acids and carbon. The monitored morphological characteristics included plant height, number of leaves, number of inflorescences, and number of buds per plant. Foliar fertilization during the crop's vegetation was carried out with the products Ergon, Aminototal Grow and Siapton. Three separate treatments were carried out in the 5-6 leaf phase with each of the fertilizers every seven days.

Variants of the experiment:
Variant 1. Control (untreated)
Variant 2. Application of Ergon foliar fertilizer, at a dose of 0.1%
Variant 3. Application of Aminototal Grow foliar fertilizer, at a dose of 0.025%
Variant 4. Application of Siapton foliar fertilizer, at a dose of 0.25%

Characteristics of foliar fertilizers:
Ergon is an organic nitrogen fertilizer that contains 19 amino acids and an extract from algae (*Ascophyllum nodosum*). The content of organic carbon of biological origin (C) is 12%.
Amino Total Grow is an extract of seaweed and contains 18 L-amino acids, organic nitrogen. The content of easily digestible plant L-amino acids in the organic fertilizer is over 43%.
Siapton is a universal organic liquid fertilizer and biostimulator for foliar and soil application for all crops. The specialized bio fertilizer is developed on the basis of natural hydrolyzed proteins. The fertilizer contains organic nitrogen 8.7%, ammonium nitrogen – 0.4%, organic carbon – 25%, total amino acids (of animal origin) – 54.4%, free amino acids – 10%, dry matter – 63%
The soil type is alluvial-meadow soil. It is characterized by a weak humus horizon (average 0.25 m), in which the humus content varies within narrow limits of 1.5 - 2.0%; high water permeability, with low water retention capacity; good aeration and limited field moisture capacity (LFMC) - about 14-16%; with a total porosity of the order of 30 - 42%. (Koinov et al., 1962).
In the soil layer 0-30 cm, the content of nutrient reserves is 117.19 mg/1000 g mineral nitrogen; 6.67 mg/100 g mobile phosphorus and 20.09 mg/100 g available potassium. (Stoyanova et al., 2019).
The irrigation of tomatoes, greenhouse production, was carried out using a drip irrigation system, with built-in drippers at 0.10 cm.
The results were subjected to variance and regression analysis with ANOVA.

RESULTS AND DISCUSSIONS

Tomatoes are an intensive crop, which is distinguished by rapid growth and the formation of a large leaf area. The balance between the vegetative mass and the number of flowers affects the synthesis of plastic substances and, accordingly, productivity. For this reason, morphological and phenological features were studied and monitored in different feeding options. During the two years of the study, morphological features were monitored: plant height, number of leaves, number of inflorescences and number of buds per plant in different treatment options.
During the two years of the experiment, from 30 to 32 irrigations were carried out, depending on the duration of the vegetation period and the requirements of the plants for easily accessible moisture. The irrigation rate of the applied irrigations was 15 m³/da. In the first business year, 32 irrigations were carried out, with an irrigation rate of 480 m³/da. In 2023, thirty irrigations were applied to maintain readily available moisture in the soil horizon, with an irrigation rate of 450 m³/da.

Table 1. Morphological indicators and development of tomato plants at different fertilization levels, Vermilenza

Variant	Stem Height, cm	%	Number of leaves	%	Number of inflorescences	%	Number of tomato clusters	%	Development Index
2022									
1	136	100	12	100	3	100	6	100	
2	152	111,8	14	116,7	4	133,3	7	116,7	5,00
3	153	112,5	13	108,3	6	200	9	150	6,00
4	158	116,2	15	125	6	200	10	166,7	8,00
2023									
1	118	100	15	100	4	100	5	100	
2	135	114,4	17	113,3	5	125	8	160	5,75
3	132	111,9	16	106,7	5	125	7	140	4,50
4	143	121,2	15	100	5	125	8	160	7,25
Average									
1	127	100	13,5	100	3,5	100	5,5	100	
2	143,5	113	15,5	114,82	4,5	128,6	7,5	136,4	5,38
3	142,5	112,2	14,5	107,41	5,5	157,1	8	145,5	5,25
4	150,5	118,5	15	111,11	5,5	157,1	9	163,6	7,63

On average, 31 irrigations were applied during the greenhouse tomato growing season, with an irrigation rate of 465 m³/da. Adams et al. (2019) indicated that the irrigation regime influences the return on investment and the extent of aquifer conservation. The impact of the food and the irrigation system being studied and in terms of their impact on the qualitative composition of tomatoes. They have established relationships between irrigation regimes, nutrient and dry matter content, of soluble sugars, vitamin C and organic acids (Du et al., 2017; Lahoza et al., 2016).
Morphological analyses and phenological observations were carried out from the beginning of reddening of the first fruits at

intervals of seven days (Tables 1 and 2). The conducted studies on stem growth determined the studied varieties as moderately to strongly growing from resumption of growth after planting to tip breakage.

Table 2. Morphological indicators and development of tomato plants at different fertilization levels, Grando

Variant	Stem Height, cm	%	Number of leaves	%	Number of inflorescences	%	Number of tomato clusters	%	Development Index
2022									
1	138	100	13	100	3	100	6	100	
2	156	113	14	107,7	5	166,7	12	200	6,75
3	151	109,4	14	107,7	4	133,3	11	183,3	5,00
4	164	118,8	16	123,1	6	200	13	216,7	9,75
2023									
1	121	100	12	100	4	100	5	100	
2	148	122,3	16	133,3	5	125	7	140	8,50
3	145	119,8	17	141,7	5	125	6	120	7,75
4	156	128,9	18	150	6	150	7	140	11,25
Average									
1	129,5	100	12,5	100	3,5	100	5,5	100	
2	152	117,4	15	120	5	142,9	9,5	172,7	7,63
3	148	114,3	15,5	124	4,5	128,6	8,5	154,5	6,38
4	160	123,6	17	136	6	171,4	10	181,8	10,50

The results of the morphological analysis are presented on average for one plant and show that in terms of plant height, the variants that were nourished with organic fertilizers, on average for the study period, exceed the unfertilized control by 12.2% to 18.5% for Vermilenza and by 14.3% to 23.6% for Grando. The highest values are for the variants fertilized with Siapton. The same trend was also recorded in the analysis of the number of leaves per plant. The results measured for variant 4 are 11.1% and 36.0% higher than the control variant. The results for the number of tillers indicate that the Vermilenza variety forms a 57.1% higher number in variants 3 and 4, while for the Grando variety, the highest values (71.4%) were again established in variant 4. An important indicator of plant productivity is the number of tillers. A positive trend was recorded for the nourished variants for both varieties. Variant 4 of the Grando variety stands out with the highest number of buds, with 81.8% compared to the control, followed by variant 2, with 72.7%. An increase in buds was also found in Vermilenza, but within narrower limits. The indicator is 63.6% higher in variant 4, compared to the control, followed by variant 3, with 45.5%.

A study by Zeleke et al. (2024) found that the synergy between the organic and inorganic fertilizers promoted overall plant health, water efficiency, and productivity.

Organic fertilization makes use of natural resources to enhance soil fertility and therefore is of utmost importance for sustainable agriculture with limited environmental outcomes (Amadou et al., 2020)

The monitored morphological indicators also allow the calculation of a plant development index. In this case, the development index was calculated relative to the control variant. The results show that the application of organic fertilizers increases the development index in both studied varieties. Higher index values were registered in the red tomato, Grando variety, on average for the study period. After applying the organic fertilizer Siapton, a development index ranging from 9.75 to 11.25 or 10.50 on average for the period was recorded. The variation in the Vermilenza variety is from 8.0 to 7.25 in both years and an average for the period of 7.63.

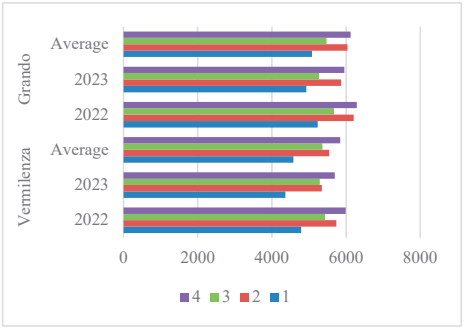


Figure 1. Total tomato yield, greenhouse production, distributed by varieties and variants, kg/da

Figure 1 presents the total yield of the two varieties by variants and years. The results show that when growing tomatoes without applying foliar treatment, the lowest values were recorded for both varieties. The main fertilization of the plants for both varieties provided yields of 5082.0 kg/da for the Grando variety and 4577.0 kg/da for the Vermilenza variety. On average for the study period, the variant treated with the organic fertilizer Siapton (6120.5 kg/da) stood out with the highest productivity for the Grando variety. Productivity was 20.4% higher compared to the control. The same trend was observed for the Vermilenza variety. When applying Siapton, results were recorded that were 27.7% higher compared to the control.

After feeding with Ergon, an increase in productivity was found by 18.8% (Grando) and 21.1% (Vermilenza) compared to the control. Treating plants with Aminototal Grow provides an increase of 7.6% to 17.2%, respectively, in the Grando and Vermilenza varieties.

Combination of organic and inorganic fertilizer treated plots produced higher yield than plots without combination of organic and inorganic fertilizer (Laily et al., 2021).

The combined application of 0.69 g of nitrogen and 75 g of Azolla per pot demonstrated the highest improvements in several key parameters, such as chlorophyll content, photosynthetic rate, stomatal conductance, relative water content, water use efficiency, and plant height. The integration of these fertilizers improves photosynthesis, water efficiency, plant height, and vegetative growth, making it a promising strategy for increasing tomato productivity in sustainable agriculture (Zeleke et al., 2024).

The influence of foliar feeding on the economic early maturity of plants was observed, and it was found that the lowest economic early maturity was observed when feeding with the universal organic liquid fertilizer Siapton (variant 4). In the control variant, the economic early maturity was characterized by the highest values (Figure 2 and Figure 3).

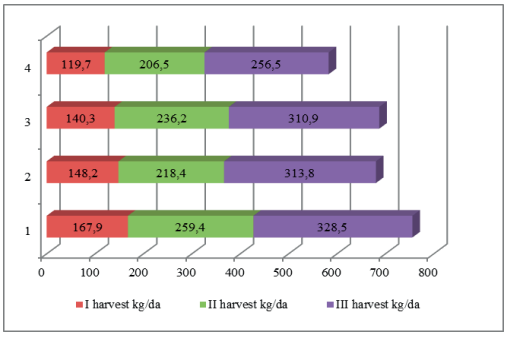


Figure 2. Economic early maturity of tomatoes, greenhouse production, variety Vermilenza, average for the period 2022-2023

The analysis of the results for early maturity of the two tomato varieties shows that the share of the third harvest is the largest, on average for the study period. The highest economic early maturity is observed in the control variant, in which there is only basic fertilization. In all other variants, the economic early maturity is lower than that in the control.

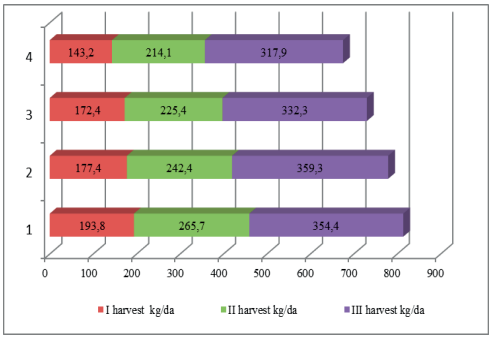


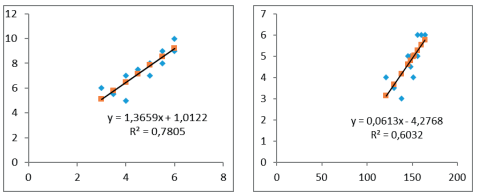
Figure 3. Economic early maturity of tomatoes, greenhouse production, variety Grando, average for the period 2022-2023

Variant 4 stands out with the lowest degree of early maturity, in the Vermilenza variety, respectively with a yield of economic early maturity of 582.7 kg/da. Productivity is 22.9% lower than in the control. While in the other variants, early maturity varies from 9.05% to 9.98%, in variants 2 and 3, respectively. A similar trend was also observed in the Grando variety, but the decrease in early maturity is 17.04% in variant 4. While in variant 2 it is only 4.28% lower compared to the non-fertilized variant. Against the background of the same irrigation regime and basic fertilization, a decrease in early maturity is reported with the application of organic fertilizers during the crop's vegetation. An analysis of variance was conducted on the results for economic early maturity, which has a significance level of $P<0.01$.

Linear regression equations were developed to determine the relationship between the studied indicators. Linear regression is a statistical method for establishing a relationship between the independent variable (height) and the dependent variable (number of inflorescences).

The correlation coefficient was calculated, which determines the strength of the relationship between the indicators. A strong positive relationship was established between the indicators "plant height" and "total yield", with a correlation coefficient for the Grando variety $r = 0.91$, and for the Vermilenza variety $r = 0.89$. High values are also observed in the correlation coefficients between the traits

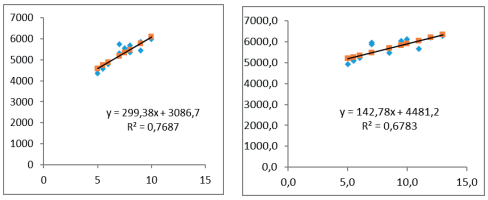
"plant height" and "number of inflorescences", respectively r = 0.88 (Vermilenza) and r = 0.78 (Grando). A high degree of positive correlation is also registered between "total yield" and "number of bunches per plant", with correlation coefficients r = 0.87 for the Vermilenza variety and r = 0.82 for the Grando variety.



a) Vermilenza b) Grando

Figure 4. Linear regression model between number of inflorescences and height in Vermilenza and Grando

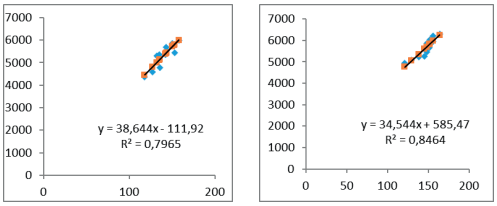
The coefficients of determination for Vermilenza (R^2 = 0.7805) and Grando (R^2 = 0.6032) were calculated. They show that 78.05% and 60.32% of the number of buds, respectively, depend on the height of the plants.



a) Vermilenza b) Grando

Figure 5. Linear regression model between the indicators Number of tomato bunches and yield

Linear regression analysis was used to present the nature of the relationship between the studied indicators and yield. The coefficient of determination (R^2 = 0.7687) was calculated for the Vermilenza variety and R2 = 0.6783 for the Grando variety.



a) Vermilenza b) Grando

Figure 6. Linear regression model between the indicators "height of a plant" and "number of inflorescences"

The analysis shows that when studying the relationship between the indicators "plant height" and "number of inflorescences", the coefficient of determination is high in both varieties, respectively in Vermilenza - R^2 = 0.7965 and in the Grando variety - R^2 = 0.8464. The nature of the relationship shows that 79.7% and 84.6% of the number of inflorescences depend on the height of the plants in the Vermilenza and Grando varieties.

Regression relationships were determined between fertilization with the macronutrients nitrogen, phosphorus, and potassium on the growth and productivity of tomato seedlings, and a high degree of influence of nitrogen on the leaf area index was found, while excessive use contributed to the deterioration of tomato quality (Patanè et al., 2010).

CONCLUSIONS

As a result of the analyses, some main conclusions were drawn:

The application of organic fertilizers increases the development index of the studied tomato varieties. On average, for the period after the application of the organic fertilizer Siapton, the highest index values were recorded for the Grando variety - 10.50 and for the Vermilenza variety - 7.63.

Against the background of the same irrigation regime and basic fertilization, a decrease in early maturity was recorded with the application of organic fertilizers during the growing season of the crop. The lowest economic early maturity was recorded in the Vermilenza variety, being 22.9% lower compared to the control.

A strong positive relationship was established between the indicators "plant height" and "total yield", with a correlation coefficient for the Grando variety r = 0.91, and for the Vermilenza variety r = 0.89.

The nature of the linear relationship between the indicators "plant height" and "number of inflorescences" was determined, with a coefficient of determination R^2 = 0.846 for the Grando variety and R^2 = 0.797 for the Vermilenza variety.

ACKNOWLEDGEMENTS

This research is supported by the Bulgarian Ministry of Education and Science under the National Program „Young Scientists and Posdoctoral Students – 2“.

REFERENCES

Adams, K., Kovacs, K. (2019). The adoption rate of efficient irrigation practices and the consequences for aquifer depletion and further adoption. *Journal of Hydrology*, 571, 244-253. DOI: 10.1016/j.jhydrol.2019.01.040.

Ahmadpour R., Armand, N. (2020). Effect of ecophysiological characteristics of tomato (*Lycopersicon esculentum* L.) in response to organic fertilizers (compost and vermicompost). *Notulae Botanicae Horti Agrobotanici Cluj-Napoca,* Vol. 48 No. 3 (2020).

Amadou, A., Song A., Tang Z.-X., Li Y., Wang E.-Z., Lu Y.-Q., Liu X.-D., Yi K., Zhang B., Fan, F. (2020). The effects of organic and mineral fertilization on soil enzyme activities and bacterial community in the below-and above-ground parts of wheat. *Agronomy* 10, 1452.

Barov V. (1982). Analysis and schemes of field experience. NAPS, Sofia.

De Sio, F., Rapacciuolo, M., De Giorgi, A., Sandei, L., Giuliano, B., Tallarita, A., Golubkina, N., Sekara, A., Stoleru, V., Cuciniello, A., Morano, G., & Caruso, G. (2021). Industrial Processing Affects Product Yield and Quality of Diced Tomato. *Agriculture* 11(3), 230; https://doi.org/10.3390/agriculture11030230

Du, Y., Cao, H., Liu, S., Gu, X., Cao, Y. (2017). Response of yield, quality, water and nitrogen use efficiency of tomato to different levels of water and nitrogen under drip irrigation in Northwestern China. *Journal of Integrative Agriculture*. Volume 16(5), 1153-1161.

Edwards C.A., Lofty, J.R. (1982). Nitrogenous fertilizers and earthworms populations in agricultural soils. *Soil Biol. Biochem*., 147 (1982), pp. 515-521

Frusciante, L., Carli, P., Ercolano, M.R., Pernice, R., Di Matteo, A., Fogliano, V., Pellegrino, N. (2007). Antioxidant nutritional quality of tomato. *Mol. Nutr. Food. Res.* 51, 609–617.

Gao F., Li H., Mu X., Gao H., Zhang Y., Li R., Cao K., Ye L. (2023). Effects of Organic Fertilizer Application on Tomato Yield and Quality: A Meta-Analysis. *Applied Sciences,* 13(4):2184. https://doi.org/10.3390/app13042184

Guo J.X., Hu, X.Y.; Gao L.M., Xie K.L., Ling N., Shen Q.R., Hu S.J., Guo S.W. (2017). The rice production practices of high yield and high nitrogen use efficiency in Jiangsu, China. *Sci. Rep*. 2017, 7, 2101.g

Khan, M. T., Aleinikovienė, J., & Butkevičienė, L.-M. (2024). Innovative Organic Fertilizers and Cover Crops: Perspectives for Sustainable Agriculture in the Era of Climate Change and Organic Agriculture. *Agronomy,* 14(12), 2871. https://doi.org/10.3390/agronomy14122871

Kostadinov, K., Filipov, S., Valcheva, V. & Kuneva, V. (2019). Influence of biological fertilization on vegetative behavior and productivity of greenhouse eggplant, *Scientific Papers, Series B. Horticulture*, LXIII (1), 297-305. ISSN 2285-5653 (Print), ISSN 2286-1580

Lahoza, I., Castro, A.P., Valcárcel, M., Macua, J.I., Beltrán, J., Roselló, S., Cornejo. J.C. (2016). Effect of water deficit on the agronomical performance and quality of processing tomato. *Scientia Horticulturae,* Volume 200, 55-65.

Laily, U.K., Rahman, M.S., Haque, Z., Barman, K.K., Talukder, M. (2021). Effects of organic fertilizer on growth and yield of tomato. *Progressive Agriculture* 32(1): 10-16, 2021

Patanè C., Cosentino, S.L. (2010). Effects of soil water deficit on yield and quality of processing tomato under a Mediterranean climate. *Agricultural Water Management*, Volume 97, Issue 1, Pages 131-138, ISSN 0378-3774, https://doi.org/10.1016/j.agwat.2009.08.021.

Riahi, A., Hdider, C., Sanaa, M., Tarchoun, N., Kheder, M. B., & Guezal, I. (2009). The Influence of Different Organic Fertilizers on Yield and Physico-Chemical Properties of Organically Grown Tomato. *Journal of Sustainable Agriculture*, 33(6), 658–673. https://doi.org/10.1080/10440040903073800

Schjonning P., B.T. Christensen. (1994). Physical and chemical properties of a sandy loam receiving animal manure, mineral fertilizer or no fertilizer for 90 years. *Eur. J. Soil Sci.,* 45, pp. 257-268

Serio F., Ayala O., Bonasia A., Santamaria P. (2006). Antioxidant Properties and Health Benefits of Tomato. In Recent Progress in Medicinal Plants (Search For Natural Drugs); Studium Press: Totnes, UK, Volume 13.

Spencer, J.P.E.; Kuhnle, G.G.C.; Hajirezaei, M.; Mock, H.-P.; Sonnewald, U.; Rice-Evans, C. (2005). The genotypic variation of the antioxidant potential of different tomato varieties. *Free Radic. Res.,* 39, 1005–1016

Stoyanova A., Kuneva, V., Valchev, N. (2019). Survey Of The Influence Of Fertilization And Irrigation In The Tomatoes, Greenhouse Production. *Scientific Papers. Series B, Horticulture*, Vol. LXIII, No. 1, Print ISSN 2285-5653, CD-ROM ISSN 2285-5661, Online ISSN 2286-1580, ISSN-L 2285-5653.

Stoyanova A., Veleva P., E. Valkova, M. Georgiev. 2020. Study of the content of antioxidants in tomatoes under the influence of different fertilization and irrigation regimes. Bulgarian *Journal of Agricultural Science*, 26 (Suppl. 1) 2020, 19-29. ISSN 1310-0351 - print; ISSN 2534-983X – online

Tejada M., J.L. Gonzalez. (2003). Effects of the application of a compost originating from crushed

cotton gin residues on wheat yield under dryland conditions. *Eur. J. Agron*., 19, pp. 357-368

Whalen J.K., C. Chang, G.W. Clayton, J.P. Carefoot. (2000). Cattle manure amendments can increase the pH of acid soils. *Soil Sci. Soc. Am. J.,* 64 , pp. 962-966

Zeleke Y.G., Haile A., Kiflu A., Alemayehu H. (2024). Morphological and physiological plasticity of tomato in response to Azolla fern, a novel organic fertilizer of environmentally friendliness. *Heliyon,* Volume 10, Issue 20.