

International Journal of Advanced Biochemistry Research



ISSN Print: 2617-4693
ISSN Online: 2617-4707
NAAS Rating: 5.29
IJABR 2025; 9(4): 469-473
www.biochemjournal.com
Received: 10-02-2025
Accepted: 13-03-2025

Eman Falah Obaid
Department of Horticulture,
College of Agriculture, Al-
Qasim Green University,
Babylon 51013, Iraq

Ali Ibadi Manea
Department of Horticulture,
College of Agriculture, Al-
Qasim Green University,
Babylon 51013, Iraq

Tahani Jawad Mohammed
Department of Horticulture,
College of Agriculture, Al-
Qasim Green University,
Babylon 51013, Iraq

The effect of mycorrhizae fungi, bacillus bacteria with some organic fertilizers on (*Solanum lycopersicum* var. *cerasiforme*) grown in unheated greenhouses

Eman Falah Obaid, Ali Ibadi Manea and Tahani Jawad Mohammed

DOI: <https://www.doi.org/10.33545/26174693.2025.v9.i4f.4135>

Abstract

The field experiment was conducted in the demonstration farm in Al-Mahnawiyah area-Al-Saddah district, affiliated to Babylon province, which is 20 km east of the province center during the fall season 2024-2025. The study included two factors: the first is adding bio-fertilizer (mycorrhizal fungi and Bacillus bacteria) at levels (without adding, 5 g, 10 g) which is symbolized by (A0, A1, A2) respectively, and the second factor is adding organic fertilizers, including (Vermicompost, poultry waste, mushroom waste, and palm frond waste) at levels (10 tons. ha⁻¹ for all types of fertilizers) which is symbolized by (B0, B1, B2, B3, B4) on the growth and productivity of cherry tomato plant. The experiment was conducted using the split plot system within the randomized complete block design (RCBD), where the land was divided into three terraces, each terrace was replicated and contained 15 experimental units. Cultivation was conducted on both sides of the terrace and drip irrigation was used. The averages of the treatments were analyzed using the least significant difference (L.S.D) test at a probability level of 0.05. The results showed that the biofertilization with mycorrhizal fungi (A1) had the highest significant increase in chlorophyll, which reached 51.86 Spad, the highest average stem diameter of 15.623 mm, the highest percentage of dry matter of the vegetative group of 24.61%, the highest percentage of nitrogen, phosphorus and potassium elements of 3.772%, 0.5246%, 1.5419% respectively, and the highest yield per plant, which reached.

The treatment with Bacillus bacteria (A2) recorded the highest average leaf area of 3229 cm.plant⁻¹. The results showed a significantly excelled in organic fertilization treatments, where the treatment with palm frond waste (B4) was excelled in giving the highest rate of chlorophyll 51.67 Spad and the percentage of dry matter in the vegetative group 24.50%. The treatment with poultry waste (B2) gave the highest rate of stem diameter 15.188 mm and leaf area as it reached 2781.7 cm. plant⁻¹ and the percentage of N element 3.648%. The treatment with vermicompost (B1) was excelled in the percentage of phosphorus element 0.4983% and the highest yield per plant. The results of the interaction between the factors indicated a significantly excelled, as treatment A1B2 achieved the highest rate of stem diameter 16.313 mm, percentage of dry matter of the vegetative group 27.14%, leaf area 3918.1 cm.plant⁻¹, nitrogen percentage 4.237% and the highest yield per plant. Treatment A2B4 achieved the highest rate of chlorophyll content of leaves, reaching 52.62 Spad, and treatments A1B1 and A1B4 recorded the highest percentage of phosphorus 0.5907%.

Keywords: Biofertilizers, organic fertilization, cherry tomato, greenhouses

Introduction

The Solanaceae family includes many important vegetable crops, among the most important crops is the tomato, including cherry tomato (*Solanum lycopersicum* var. *cerasiforme*), which is considered a type of small-sized tomato fruit. Cherry tomato is important for its nutritional content, as it contains vitamins A, B and C. Its consumption is also beneficial for human health because it contains plant chemicals such as lycopene, beta-carotene, fulvic acid, fructose, and many essential nutrients such as: phosphorus, potassium, magnesium and calcium [1]. It is considered an important source of antioxidant compounds, such as polyphenols and carotenoids [2], which work to prevent cancer and cardiovascular diseases resulting from oxidative stress [3]. Its size ranges from the thumb to the size of a golf ball, and its size is important to a number of consumers. The smaller fruits, 1.25-1.87 cm³, are used in salads and are eaten in their entire size, with preference over the large-sized varieties whose fruits need to be cut before eating, which reduces the levels of vitamin C, which is

Corresponding Author:
Eman Falah Obaid
Department of Horticulture,
College of Agriculture, Al-
Qasim Green University,
Babylon 51013, Iraq

susceptible to oxidation when the fruits are cut, while the uncut fruits will retain the same amount of this vitamin without oxidation, which increases the chance of benefiting from it directly without losing it, and its fruits are not exposed to blossom end rot ^[4]. This encourages its cultivation in the central, southern and desert regions of Iraq. Cherry tomato is characterized by high productivity and quality, and enjoys excellent consumer acceptance due to its high sweetness and distinctive taste that many prefer over regular tomatoes ^[5]. The importance of environmentally friendly biofertilizers has increased to improve the performance of plant crops within the sustainable agriculture system, as mycorrhizal fungi shorten the vegetative growth period of tomato plants and thus lead to early maturity of flowers and fruits ^[6]. In addition, there are studies that confirm that the interaction of tomato plants with AMF increases the quality of nutrients by increasing the content of citric acid, carotenoids, some amino acids and the antioxidant capacity of fruits ^[7, 8]. Organic fertilizer is a product of plant, animal or industrial-agricultural origin that when added to the soil improves soil fertility and increases crop productivity and product quality ^[9]. Studies on tomatoes have shown that antioxidants, flavonoids, sugars and vitamin C are higher in organically grown fruits compared to conventionally grown fruits ^[10, 11, 12]. A study showed that a 15.66% higher yield was obtained when using organic fertilizers compared to chemical fertilizers, which increased the tomato yield by 28.9%, the highest yield. All applications showed an increase in soil CO₂ production; the highest CO₂ production was determined in the last harvest period and after fertilizer application, tomato yield increased and soil biological properties improved ^[13]. Another study showed that when using organic fertilizers, the highest yield and mineral content in fruits were achieved at a dose of 35 ml for tomato plants. At these doses, tomato fruit weights increased by 137%, compared to the control treatment ^[14].

Materials and Methods

The field experiment was conducted during the agricultural season. 2024-2025 in Al-Mahnawiyah area, Al-Saddah district, which is located 20 km east of the center of Hillah city (Babylon Province) for the purpose of studying the effect of biofertilizers and organic fertilizers on the growth and yield of cherry tomato. The field soil designated for implementing the experiment was prepared by cleaning it from the remains of the previous crop and carrying out the

pasteurization process. After that, it was plowed, smoothed and leveled in a homogeneous manner. The land was divided into three terraces so that each replicate includes 15 experimental units. The replicate contains a terrace with a width of 1 m and a length of 1.5 m and a distance of 1 m between the terrace and the other and a distance of 70 cm between one experimental unit and another that acts as an insulator to prevent mixing between treatments and between one plant and another 50 cm. After that, the drip irrigation system was installed. The seeds were planted on 9/14/2024 in cork plates filled with peat moss and perlite for the purpose of producing seedlings. After 35 days, they were transferred to the plastic house and planted on 10/18/2024. The experiment was conducted using a randomized complete block design (RCBD). The experiment included the use of two factors: The first factor: symbolized by the symbol A and includes biofertilizers that represent three types of biofertilizer

A0 represents control treatment

A1 Mycorrhizal fungi at a concentration of 5 g/plant

A2 Bacillus bacteria at a concentration of 10 g/plant

The biofertilizers were prepared by the Agricultural Research Department / Biotechnology Center / Ministry of Science and Technology and added when planting the seedlings

The second factor: Using organic fertilizers includes 5 types of organic fertilizers and includes (Vermicompost B1, poultry waste B2, mushroom waste B3, palm frond waste B4 and B0 represents control treatment) The amount of addition for all organic fertilizers is 10 tons/ha. The organic fertilizers were added before planting the seedlings. The experiment was conducted as a factorial experiment (5*3) using randomized complete blocks (RCBD) according to the split-plot system with three replicates. Biofertilization was distributed on the main plot and organic fertilizers on the sub-plot. The averages of the treatments were analyzed using the least significant difference (L.S.D) test at a probability level of 0.05, and the statistical program Genstat V.12 was used to analyze the experimental data ^[14].

5 plants were selected from each experimental unit for the purpose of conducting measurements (measuring the leaf chlorophyll content (SPAD), stem diameter, leaf area (cm².plant⁻¹), percentage of dry matter of the vegetative group, and percentage of nitrogen, phosphorus, potassium in the leaves, and yield of one plant.

Table 1: Physical and chemical traits of the field soil before planting

Traits	Standard unit	Values
Electrical Conductivity (EC)	3 m/ds	3.4
pH	---	7.8
Organic Matter	g. kg ⁻¹	0.56
Available Nitrogen	mg. kg ⁻¹	20
Available Phosphorus	mg. kg ⁻¹	8.6
Available Potassium	g. cm ³	152.6
Bulk Density	Standard unit	1.3
Soil Texture	silty-clay-loam	

Table 2: Properties and components of organic fertilizers used in the experiment

Traits	units	Poultry waste	Vermicompost	Palm fronds	Mushroom bed
pH	-	6.6	6.8	7.04	7.3
Organic carbon	%	14.9	10.16	43.70	335
Nitrogen	%	2.23	3.498	2.30	25.0
C:N	-	6.7	8.1	19.00	13.4
Phosphorus	%	0.83	1.73	0.650	12.3
Potassium	%	2.35	2.23	2.80	230.5
Calcium	%	1.42		2.93	
Magnesium	%	0.58		0.850	

Results and Discussion

The results in Table (3) indicated that the addition of biofertilizers significantly affected the vegetative growth traits, where the treatment with mycorrhizal fungi excelled on the leaf chlorophyll content traits 51.86 Spad, the highest rate of stem diameter 15.623 mm and the highest percentage of dry matter of the vegetative group 24.61%, while control treatment recorded the lowest rate for the above traits and reached 45.78, 14.142, 20.51 respectively. As for the treatment with *Bacillus* bacteria, it gave the highest rate of leaf area reaching 3229.3 cm. plant⁻¹, while control treatment A0 recorded the lowest rate of area 1048.9 cm. plant⁻¹. It is clear from the same table that the treatment with organic fertilizers had a significant effect on the vegetative growth traits, as the treatment with palm frond wastes was excelled in giving the highest rate of chlorophyll 51.67 Spad and the percentage of dry matter of the vegetative group 24.50%, while control treatment recorded 47.45 Spad, 21.18%. respectively. As for the treatment with poultry waste, it gave the highest rate of stem diameter 15.188 mm and leaf area, which reached 2781.7 cm. plant⁻¹, while control treatment recorded 14.041 mm, 1733.7 cm. plant⁻¹. As for the interaction treatment, treatment A1B2 recorded the highest rate of stem diameter 16.313 mm, percentage of dry matter of the vegetative group 27.14% and leaf area 3918.1 cm. plant⁻¹. While the control recorded 12.727 mm, 16.63%, 993.1 cm. plant⁻¹ respectively. Treatment A2B4 achieved the highest rate of chlorophyll content of leaves and reached 52.62 Spad while the control recorded 39.94 Spad.

Results

The results in Table 4 showed that the mycorrhizal treatment was significantly excelled in qualitative traits and gave the highest rate of nitrogen, phosphorus and potassium in the leaves 3.772%, 0.524% and 1.5419% respectively and the highest percentage of vitamin C, which reached 22.18 while control treatment was 2.709, 0.3522, 1.0535, 10.35 respectively. The same table shows that when treated with organic fertilizers, there was a significantly excelled in the qualitative traits of the plant, as treatment B2 gave the highest percentage of the N element 3.648% while control treatment recorded 2.831%. The (Vermicompost) treatment B1 was excelled in the highest percentage of the phosphorus element 0.4983% while the control was 0.3733%. Treatment B4 recorded the highest value of vitamin C, which reached 17.54, while the control reached 15.04. As for the interaction between the studied factors, it achieved a significantly excelled, as treatment A1B0 achieved the highest percentage of potassium, which reached 1.7267%, while the control reached 1.0407%. Treatments A1B1 and A1B4 excelled by recording the highest percentage of phosphorus, 0.5907%, while the control was 0.2347%. Treatment A1B4 also recorded the highest value of vitamin C, which reached

23.63, while the control recorded 8.83. Treatment A1B2 recorded the highest percentage of nitrogen, 4.237%, while the control recorded 2.430%.

Discussion

The increase in vegetative growth indicators and qualitative traits of cherry tomato plant when treated with mycorrhizal fungi played a role in improving the efficiency of nutrient absorption by regulating the hormonal balance in the plant, where it is characterized by the production of plant hormones (indole acetic acid, cytokinins and gibberellins) that stimulate growth, which it secretes in the rhizosphere and is transferred to the plant tissues through the symbiotic relationship with mycorrhizal fungi and works to increase the growth and yield of plants inoculated with it, and encourages the production of antioxidant plant hormones when the plant is exposed to various environmental stresses. It has a noticeable effect on plant growth as it can stimulate plant growth by increasing the availability of nutrients, supplying the plant with water, tolerating various environmental stresses and resisting diseases that affect the plant, as a result, the addition of mycorrhizal fungi has achieved success in increasing the growth of the root system, the vegetative system and the yield of various crops due to the high affinity between the roots of these crops and mycorrhizal fungi. This is consistent with the study [15, 16, 17]. As for *Bacillus* bacteria, it gave the highest value for the total leaf area of the plant because it is considered the bacteria that enhances plant growth, as this type of bacteria *B. subtilis* affects the mineralization of organic phosphate and the dissolution of inorganic phosphate and its ability to produce 6.48 µg ml⁻¹ of plant growth hormone IAA, which is consistent with the study [18].

The effect of organic fertilizer: The reason for the increase in the content of chlorophyll in the leaves and the increase in the percentage of dry matter and the increase in the percentage of vitamin C when adding palm frond fertilizer is attributed to the fact that they are materials that enhance soil fertility effectively. Naturally decomposed materials act as a rich fertilizer. These fertilizers contain percentages of important nutrients, as indicated by the researcher [19] and [22]. It was found that the percentage of P element increased when treated with vermicompost. This is due to the fact that earthworms secrete organic fertilizer rich in major and minor nutrients essential for plant nutrition and growth, as well as containing bacteria and fungi that dissolve phosphorus compounds, fix nitrogen, and secrete growth hormones. This is consistent with the study [20]. When treated with poultry waste, an increase in the diameter of the stem and the total leaf area of the plant was observed, as well as an increase in the percentage of the N element and an increase in the yield of a single plant because it works to develop the soil in its physical state by improving the structure of the soil particles, thus, the number of groups of

beneficial heterogeneous bacteria in the soil increases by adding poultry waste, as these bacteria grow with the availability of organic materials, and they also contain almost all the essential nutrients for the plant: 65.5%

nitrogen, 83.5% potassium, and 68.5% phosphorus. It also contains calcium, magnesium, copper, iron, manganese, sulfur, boron, molybdenum, cobalt, and zinc, which is what they reported ^[21] in their study.

Table 3: Effect of biofertilizers and organic fertilizers on the growth and yield of cherry tomato

Bio fertilization	Chlorophyll	Stem diameter	% dry matter	Leaf area
Control	45.78	14.142	20.51	1048.9
A1	51.86	15.623	24.61	2978
A2	51.22	14.681	24.26	3229.3
LSD0.05	0.990	0.5888	0.628	100.86
Organic fertilization				
control	47.45	14.041	21.18	1733.7
B1	49.19	14.902	22.32	2778.7
B2	49.63	15.188	24.01	2781.7
B3	50.17	14.942	22.99	2327.3
B4	51.67	15.004	24.50	2472.4
LSD0.05	0.905	0.4394	0.949	60.30
interaction A*B				
A0B0	39.94	12.727	16.63	993.1
A0B1	44.11	14.110	17.58	1092.1
A0B2	46.45	14.683	21.73	1020.6
A0B3	48.21	14.753	21.55	1102.1
A0B4	50.19	14.437	25.04	1036.7
A1B0	51.48	15.433	22.63	1519.3
A1B1	52.40	15.687	24.71	3512.2
A1B2	52.18	16.313	27.14	3918.1
A1B3	51.05	15.317	23.78	2834.8
A1B4	52.19	15.367	24.80	3105.8
A2B0	50.93	13.963	26.17	2688.6
A2B1	51.07	14.910	24.67	3731.8
A2B2	50.26	14.567	23.18	3406.3
A2B3	51.23	14.757	23.63	3044.9
A2B4	52.62	15.210	23.65	3274.7
LSD0.05	1.575	0.8099	1.533	121.66

Table 4: Effect of biofertilizers and organic fertilizers on the growth and yield of cherry tomato

Biofertilizers	Nitrogen	Phosphorus	Potassium	Vitamin C
Control	2.709	0.3522	1.0535	10.35
A1	3.772	0.5246	1.5419	22.18
A2	3.265	0.4045	1.3591	16.63
LSD0.05	0.2138	0.01560	0.02621	0.948
Organic fertilization				
control	2.831	0.3733	1.4033	15.04
B1	3.416	0.4983	1.3303	16.34
B2	3.648	0.4391	1.2989	17.22
B3	3.244	0.3897	1.2867	15.79
B4	3.106	0.4351	1.2716	17.54
LSD0.05	0.1352	0.01158	0.02489	0.721
interaction				
A0B0	2.430	0.2347	1.0407	8.83
A0B1	2.887	0.4527	0.9410	10.10
A0B2	3.043	0.4367	1.0250	10.67
A0B3	2.573	0.2737	1.0850	10.10
A0B4	2.613	0.3633	1.1757	12.07
A1B0	3.407	0.5377	1.7267	20.93
A1B1	3.907	0.5907	1.7213	21.50
A1B2	4.237	0.4467	1.7057	23.37
A1B3	3.827	0.4573	1.3527	21.47
A1B4	3.438	0.5907	1.2033	23.63
A2B0	2.657	0.3477	1.4427	15.37
A2B1	3.453	0.4517	1.3278	17.43
A2B2	3.663	0.4340	1.1660	17.63
A2B3	3.333	0.4380	1.4223	15.80
A2B4	3.220	0.3513	1.4357	16.93
LSD0.05	0.2657	0.02138	0.04294	1.320

Conclusion

We conclude from this study that the treatment of interaction of mycorrhizae with poultry waste achieved the highest plant yield, and the treatment of Bacillus bacteria with palm frond waste and mycorrhizae with poultry waste achieved the highest vegetative traits, and the treatment of mycorrhizae with vermicompost achieved the highest percentage of qualitative traits.

Acknowledgments

We are grateful to the University of Al-Qasim Green for its support of this research project.

Authors Contribution

Eman Falah Obaid: Conceived, designed, coordinated data collection, data analysis, and writing the draft manuscript.

Ali Ibadi Manea: Conceived, designed, coordinated data collection, data analysis, and writing the draft manuscript

Tahani Jawad Mohammed: Conceived, designed, coordinated data collection, data analysis, and writing the draft manuscript

Conflict of Interest

The authors declare that there is no conflict of interest

Data Availability

All relevant data are within the paper and its supporting information files

Ethics approval

Not applicable to this work

References

1. Al-Rawi KM, Allah AAMK. Design and analysis of agricultural experiments. Mosul: Dar Al-Kutub Foundation for Printing and Publishing, University of Mosul; 2000. p. 488.
2. Filgueira FAR. Novo manual de olericultura: agrotecnologia moderna na produção e comercialização de hortaliças. 3rd ed. Viçosa: Federal University of Viçosa; 2013. p. 421.
3. Kalogeropoulos N, Chiou A, Pyriochou V, Peristeraki A, Karathanos VT. Bioactive phytochemicals in industrial tomatoes and their processing byproducts. LWT-Food Science and Technology. 2012;49(2):213-216.
4. Gong Y, Sohn H, Xue L, Bjeldanes GL. 3,3'-Diindolylmethane is a novel mitochondrial H(+)-ATP synthase inhibitor that can induce p21(Cip1/Waf1) expression by induction of oxidative stress in human breast cancer cells. Cancer Research. 2006;66(9):4880-4887.
5. Yuma County Cooperative Extension (YCCE). Cherry tomato report. USA: YCCE; 2007.
6. Preczenhak AP. Caracterização agronômica de genótipos de minitomate. Horticultura Brasileira. 2014;32(3):348-356.
7. Chialva M, Zouari I, Salvioli A, Novero M, Vrebalov J, Giovannoni JJ, Bonfante P. *Gr* and *hp-1* tomato mutants unveil unprecedented interactions between arbuscular mycorrhizal symbiosis and fruit ripening. Planta. 2016;244:155-165.
8. Miranda H, Ehret DL, Krumbein A, Leung C, Murch S, Turi CE, *et al.* Inoculation with arbuscular mycorrhizal fungi improves the nutritional value of tomatoes. Mycorrhiza. 2015;25:359-376.
9. Di Fossalunga AS, Zouari I, Chalot M, Bonfante P. The arbuscular mycorrhizal status has an impact on the transcriptome profile and amino acid composition of tomato fruit. BMC Plant Biology. 2012;12:44.
10. Tarni PE, Terra MM, Tecchio MA, Teixeira LAJ, Hanasiro J. Organic fertilization of vegetables and fruits. Campinas: IAC; 2013. p. 16.
11. Chassy AW, Bui L, Renaud EN, Van Horn M, Mitchell AE. Three-year control of the content of antioxidant microconstituents and several quality traits in organic and conventionally managed tomatoes and bell peppers. Journal of Agricultural and Food Chemistry. 2006;54:8244-8252. <https://doi.org/10.1021/jf060950p>
12. Mitchell AE, Hong YJ, Koh E, Barrett DM, Bryant DE, Denison RF, Kaffka S. Ten-year control of the influence of organic and conventional crop management practices on the content of flavonoids in tomatoes. Journal of Agricultural and Food Chemistry. 2007;55:6154-6159. <https://doi.org/10.1021/jf070344+>
13. Vallverdú-Queralt A, Jáuregui O, Medina-Remón A, Lamuela-Raventós RM. Evaluation of a method to characterize the phenolic profile of organic and conventional tomatoes. Journal of Agricultural and Food Chemistry. 2012;60:3373-3380. <https://doi.org/10.1021/jf204702f>
14. Durmuş M, Kızılkaya R. The effect of tomato waste compost on yield of tomato and some biological properties of soil. Agronomy. 2022;12(6):1253. <https://doi.org/10.3390/agronomy12061253>
15. Adekiya AO, Dahunsi SO, Ayeni JF, Aremu C, Aboyeji CM, Okunlola F, Oyelami AE. Organic and in-organic fertilizers effects on the performance of tomato (*Solanum lycopersicum*) and cucumber (*Cucumis sativus*) grown on soilless medium. Microbiology Programme, College of Agriculture, Engineering and Science, Bowen University, Nigeria; 2022. [Landmark University SDG 15 Research Group]
16. Nirmalnath PJ. Molecular diversity of agricultural arbuscular mycorrhizal fungi and pink pigmented facultative methylophilic bacteria and their influence on grapevine (*Vitis vinifera*). Dharwad: University of Sciences; 2010.
17. Baum C, El-Tohamy W, Gruda N. Increasing the productivity and product quality of vegetable crops using arbuscular mycorrhizal fungi: a review. Scientia Horticulturae. 2015;187:131-141.
18. Al-Hadidi N, Pap Z, Ladányi M, Szentpéteri V, Kappel N. Mycorrhizal inoculation effect on sweet potato (*Ipomoea batatas* L.) Lam seedlings. Agronomy. 2021;11(10):1-10.
19. Hanif MK, Hameed S, Imran A, Naqqash T, Shahid M, Van Elsas JD. Isolation and characterization of a B-propeller gene-containing phosphobacterium *Bacillus subtilis* strain KPS-11 for growth promotion of potato (*Solanum tuberosum* L.). Frontiers in Microbiology. 2015;6:1-11.
20. Jeki M. Pengaruh pemberian kompos pelepah sawit terhadap pertumbuhan bibit kelapa sawit (*Elaeis guineensis* Jack). Skripsi. Program Studi Agroteknologi, Fakultas Pertanian, Universitas Pasir Pengaraian; 2021.
21. Abbey L, Rao SA, Hodgins N, Briet L, Abbey C, Young C, *et al.* The wonders of earthworms and its vermicompost in farm production: Charles Darwin's friends of farmers, with potential to replace destructive chemical fertilizers. American Journal of Plant Nutrition and Fertilization Technology. 2012;3(1):1-13.
22. Hamidu JA, Osie-Adjei A, Oduro-Owusu AD. Poultry waste management-manure. In: Encyclopedia of Meat Sciences. 2nd ed. 2024. <https://doi.org/10.1016/b978-0-323-85125-1.00136-8>
23. Manea AI. Fertilizer type on cabbage growth and yield. International Journal of Vegetable Science. 2017;23(6):567-574. <https://doi.org/10.1080/19315260.2017.1350245>