SCIENTIFIC BASIS AND SYSTEM ANALYSIS OF ORGANIC CULTIVATION OF SAFFRON AND ITS IMPORTANCE

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Abstract: *This article presents a scientific basis and system analysis of the organic cultivation of saffron (Crocus sativus L.) using non-traditional biological fertilizers, specifically zoohumus derived from the edible insect Tenebrio molitor. The study evaluates the impact of various biofertilizer concentrations (ranging from 10 g to 100 g per 5 L of substrate) on saffron growth parameters, including shoot formation, leaf length and count, root development, and flower stigma characteristics (length and dry weight). Experimental results indicate that a zoohumus concentration of 30 g / 5 L substrate provides the optimal physiological conditions for root formation, mother bulb growth, and overall plant productivity compared to both untreated natural soil and traditional vermicompost. Applying organic biofertilizers enhances saffron yield without compromising quality standards set by ISO-3632, offering a sustainable alternative to chemical mineral fertilizers in saffron cultivation.*

Keywords: *Saffron (Crocus sativus L.), organic agriculture, biofertilizers, zoohumus, Tenebrio molitor, plant growth parameters, stigma yield, soil fertility.*

Introduction. Saffron is grown in all regions from 0 to 90 degrees east longitude, that is, from Spain to Kashmir (India), from 30 to 45 degrees north latitude, that is, from Persia to England, 80% of the world’s saffron production comes from Iran, Spain and India [1-2]. The main saffron-producing countries are also recognized as Italy, Morocco, France, Greece, Mexico and the People's Republic of China [3]. The price of high-quality saffron is estimated at 15,000-20,000 euros/kg [4]. In the United States, by 2024, the wholesale price of one kilogram of saffron is estimated from 813.04 to 1679.83 dollars, and the wholesale price of one pound of saffron is from 368.72 to 761.83 dollars. [5]. In the world, the demand for growing products based on the principles of organic farming is growing every day [6]. The widespread introduction of a management system in agricultural practice based on organic or biological farming is important for the development of sustainable agriculture. The main principle of organic or biological farming is to minimize the use of chemical mineral fertilizers and gradually phase out the use of chemical mineral fertilizers [7-8].

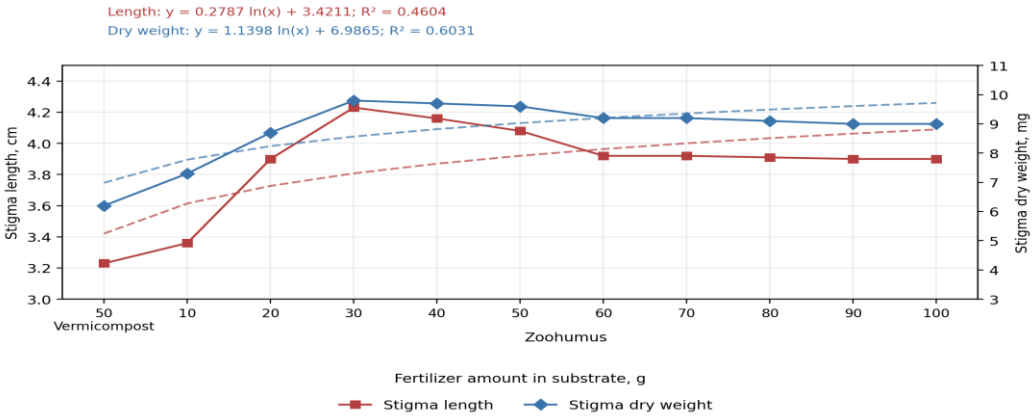
Literature revie: Wide application of the principles of organic farming in practice makes it possible to rationally manage the efficient use of soil. In particular, reducing soil degradation to a minimum level makes it possible to increase soil fertility, ensure the growth of crops in a rich organic environment, achieve high productivity and obtain natural, chemical-free products [9-11].

In recent years, the cultivation of saffron in a plantation style has become widespread, and one of the next tasks is to grow saffron based on the principles of organic farming [12]. It is known from scientific sources that saffron grown on the basis of organic principles has a high degree of retention of essential substances, while the number of flowers, the length of the stigmas in the flowers and its dry weight are of great importance [13-14]. Also, how much a plant specialized for

growing on the basis of new organic fertilizers can achieve is explained by the formation of shoots, changes in the root system, the number and length of leaves, as well as the chlorophyll-static properties of saffron [15].

Scientific centers around the world are conducting large-scale studies on the effect of saffron, its quality and productivity when grown on the basis of mineral and biological fertilizers of various compositions [16-18]. In particular, every day there is increasing attention to practical research on growing saffron on the basis of organic farming [19-20]. Also, in areas with increased alkalinity and the need for phosphorus [21], in areas with increasing water deficit and drought, the treatment of saffron fields with organic fertilizers based on organic agricultural waste allows achieving high yields [22]. In many articles published in recent years, the main focus of scientific researches are biofertilizers based on humic acids [17], biological fertilizers of various compositions [19], mineral fertilizers [23, 18] and nanonutrients [24-26], but insufficient attention is paid to non-traditional biological fertilizers. In particular, in recent years, insufficient research has been conducted on enriching the organic composition of soils with zoohumus obtained from nutritive insects, increasing the productivity of medicinal plants based on this zoohumus, and determining the parameters for maximum preservation of the main substance. Many scientific sources note that the yield of saffron bulbs and flowers directly depends on the content of nutrients. [27-29, 16, 30]. It was noted that these scientific theories were confirmed in the course of our studies.

Results and discussion: Optimum concentrations of zoohumus obtained from the edible insect Tenebrio molitor used in growing saffron were determined. Zoohumus was used as a model biofertilizer, biohumus, as well as the natural soil of the Botanical Garden without treatment as a control. In particular, the results were obtained on the basis of saffrons grown on substrates with a zoohumus concentration of 60-100 g/5 l compared to the control, as well as with the results on the basis of saffrons grown on substrates with concentrations of 10 g/5 l, 20 g/5 l, 40 g/5 l and 50 g/5 l of saffron shoots, it was noted that they gradually decreased. Thus, the results obtained on the formation of shoots, shoot weight, number and length of leaves when growing saffron on the basis of zoohumus showed that the optimal concentration of zoohumus in the substrate is 30 g/5 l [31]. Also, the results of the studies on the number of fibrous roots, average root length, wet root weight and dry root weight of saffron grown in a zoohumus substrate of 50-100 g / 5 l showed positive results compared to the control, but negative indicators were noted compared to the results in a zoohumus substrate of 20-40 g / 5 l. Analyzing the obtained results in a comparative way, it was found that it is advisable to take a concentration of 30 g / 5 l as a concentration that has an optimal effect on the formation of fibrous roots, the formation and size of mother bulbs. Based on the obtained results, it was concluded that compared to vermicompost, which is considered a traditional biological fertilizer, it is important to grow saffron using zoohumus obtained from the edible insect *Tenebrio molitor*.



Biologik o‘g‘itlarning za’faron gullari stigmalari uzunligi va quruq vazniga ta’siri (o‘simlik soni, n=50, takrorlashlar soni n=5 marotaba, p<0,01)

Our study emphasizes the importance of nutrient application and their timing to increase saffron yield. These results indicate that the inclusion of biological fertilizers (like zoohumus and vermicompost) at various concentrations can enhance the yield of saffron without compromising its quality characteristics, which remained within the natural limits set by ISO-3632. Considering the above facts, this review was undertaken to provide knowledge and better understanding of the fertilization requirements of saffron and to support management and fertilizer development strategies based on the available scientific findings.

Conclusion: The findings of this study confirm that organic farming principles, particularly the use of insect-derived zoohumus (Tenebrio molitor), significantly enhance the cultivation efficiency and yield of saffron. The concentration of 30 g / 5 L substrate was determined as the most effective optimal level for promoting biomass growth, fibrous root development, and high-quality stigma formation. Substituting chemical mineral fertilizers with non-traditional biofertilizers like zoohumus not only ensures high productivity meeting ISO-3632 quality limits, but also prevents soil degradation and supports environmentally sustainable agricultural practices.

REFERENCES

1. Sameer S.S., Bashir S., Nehvi F.A., Iqbal A.M., Naseer S., Nagoo S.A., Dar N.A. 2012. Effect of biofertilizers, biological control agents and soil amendments on the control of saffron corm rot (*Crocus sativus* L.). In: IV International Symposium on Saffron Biology and Technology. 1200. Pp.121-124. https://doi.org/10.17660/ActaHortic.2018.1200.20
2. Fazil S., Asif M.Iqbal., Sofi M.D., Mahdi S.S., Jeelani F., Khan M.H., Allai B.A., Dar N.A., Mir H., Asif B. Shikari., Bangroo S., Soliha M., Tanveer A. Ahngar. 2024. Estimation of genetic variability in saffron (*Crocus sativus* L.) germplasm for morphological and quality traits. Journal of Scientific Research and Reports, 30(6). Pp. 745-763.
3. Husaini A., Shafiq A., Parvaze S., Rather G., Parray A., Shikari A., Javid M. 2009. Bioinformatics for saffron (*Crocus sativus* L.) improvement. Communications in Biometry and Crop Science, 4(1). Pp.3-8.
4. Maleki F., Kazemi H., Siahmarguee A., Kamkar B. 2017. Development of a land use suitability model for saffron (*Crocus sativus* L.) cultivation by multi-criteria evaluation and spatial analysis. Eco Eng. 106. Pp.140-153. http://dx.doi.org/10.1016/j.ecoleng.2017.05.050

5. Selina Wamucii. 2024. https://www.selinawamucii.com/insights/prices/united-states-of-america/saffron/
6. Eshkobilov S A., Abdikholikova F.N., Kuchkarova D.X., Khujamshukurov N.A. 2023. Cultivation of Cucumbers in Greenhouse Conditions: No Chemical Pollution. European Journal of Applied Sciences, Vol - 11(3). 750-792. https://doi.org/10.14738/aivp.113.14926
7. Delmotte S., Barbier J.M., Mouret J.C., Le Page C., Wery J., Chauvelon P., Sandoz A., Lopez Ridaura S. 2016. Participatory integrated assessment of scenarios for organic farming at different scales in Camargue, France. Agric. Syst. 143. Pp.147-158. https://doi.org/10.1016/j.agsy.2015.12.009
8. Eyhorn F., Muller A., Reganold J.P., Frison E., Herren H.R., Luttikholt L., Mueller A., Sanders J., Scialabba N.E.-H., Seufert V., Smith P. 2019. Sustainability in global agriculture driven by organic farming. Nat. Sustain. 2. Pp.253-255. https://doi.org/10.1038/s41893-019-0266-6
9. Cerda A., Franch-Pardo I., Novara A., Sannigrahi S., Rodrigo-Comino J. 2021a. Examining the effectiveness of catch crops as a nature-based solution to mitigate surface soil and water losses as an environmental regional concern. Earth Syst. Environ. 6. Pp.29-44.
10. Cerda A., Terol E., Daliakopoulos I.N. 2021b. Weed cover controls soil and water losses in rainfed olive groves in Sierra de Enguera, eastern Iberian Peninsula. Journal of Environmental Management, 290(2021). Pp.1-9. https://doi.org/10.1016/j.jenvman.2021.112516
11. Negi Y.K., Sajwan P., Uniyal Sh., Mishra A.C. 2021. Enhancement in yield and nutritive qualities of strawberry fruits by the application of organic manures and biofertilizers. Scientia Horticulturae, Vol.283. Pp. https://doi.org/10.1016/j.scienta.2021.110038
12. Fallahi H., Behdani M.A., Moghaddam P.R., Al-Ahmadi M.J. 2021. Principles of standardization for organic saffron production in Iran. Saffron agronomy and technology. Vol.9, Issue 1 (31). Pp. 43-79. https://doi.org/10.22048/jsat.2020.236760.1402
13. Kumar R., Sharma O.C. 2017. Saffron (*Crocus sativus* L.) growth and yield as influenced by organic farming practices Journal of Agriculture and Ecology, 2017, Vol.4. Pp.25-32.
14. Latif S., Zargar M.Y., Nehvi F.A., Ajaz M., Ahmad M.S. 2022. Production of organic Saffron (*Crocus sativus*) using biofertilizer and vermicompost. Indian Journal of Agricultural Sciences 92 (12). Pp.1520-1523. https://doi.org/10.56093/ijas.v92i12.119531
15. Seyyedi S.M., Ebrahimian E., Rezaei-Chiyaneh E. 2018. Saffron daughter corms formation, nitrogen and phosphorous uptake in response to low planting density, sampling rounds, vermicompost and mineral fertilizers. Communications in Soil Science and Plant Analysis 49(5). Pp. 585-603. https://doi.org/10.1080/00103624.2018.1432634
16. Hourani W. 2022. Effect of fertilizers on growth and productivity of saffron: a review. Agron. Res. 20. Pp.87-105. https://doi.org/10.15159/AR.22.082
17. Shajari M.A., Moghaddam P.R., Ghorbani R., Koocheki A. 2022. Does nutrient and irrigation managements alter the quality and yield of saffron (*Crocus sativus* L.)? Agriculturae Water Management 267:107629. https://doi.org/10.1016/j.agwat.2022.107629
18. Azari S. J., Sorooshzadeh A., Nabati J., Oskoueian E. 2023. Relationship between fertilization and planting depths on antioxidant activity in saffron (*Crocus sativus* L.). Industrial Crops and Products 191(Part A):116004. https://doi.org/10.1016/j.indcrop.2022.116004
19. Esmaeilian Y., Amiri M.B., Neamatollahi E. 2022b. High density planting and manure affect flower yield, corm characteristics, and volatile compounds of saffron (*Crocus sativus* L.). Industrial Crops and Products 176:114363. https://doi.org/10.1016/j.indcrop.2021.114363

20. Chamkhi I., Sbabou L., Aurag J. 2023. Improved growth and quality of saffron (Crocus sativus L.) in the field conditions through inoculation with selected native plant growth promoting rhizobacteria (PGPR). Industrial Crops and Products 197:116606. https://doi.org/10.1016/j.indcrop.2023.116606
21. Afshari R.T., Seyyedi S.M., Mirmiran S.M. 2023. Clean application of pistachio residues-based vermicompost with γ-aminobutyric acid can alleviate the negative effects of high soil pH on P uptake in saffron (*Crocus sativus* L.). Industrial Crops and Products, 95:116443. https://doi.org/10.1016/j.indcrop.2023.116443
22. Aboueshaghi R.S., Omid, H., Bostani A. 2023. Assessment of changes in secondary metabolites and growth of saffron under organic fertilizers and drought. Journal of Plant Nutrition, 46(3). Pp.386-400. https://doi.org/10.1080/01904167.2022.2068439
23. Khorramdel S., Nasrabadi S.E., Mahmoodi G. 2015. Evaluation of mother corm weights and foliar fertilizer levels on saffron (*Crocus sativus* L.) growth and yield components. Journal of Applied Research on Medicinal and Aromatic Plants, 2(1). Pp. 9-4. https://doi.org/10.1016/j.jarmap.2015.01.002
24. Rikabad M.M., Pourakbar L., Moghaddam S.S., Djordjevic J.P. 2019. Agrobiological, chemical and antioxidant properties of saffron (*Crocus sativus* L.) exposed to TiO_2 nanoparticles and ultraviolet-B stress. Industerial Crops and Products, 137:137143.
25. Mahmoodi F., Mahdinezhad N., Fakheri B.A., Ahmadian A. 2021. Effect of silver nanoparticles and corm weight on physiological and morphological traits of saffron (*Crocus sativus*) under Sistan climatic conditions. Journal of Plant Environmental Physiology, 16(61). Pp.45-63.
26. Khoshpeyk S., Haghghi R.S., Ahmadian A. 2022. The effect of irrigation water quality and application of silicon, nanosilicon and superabsorbent polymer on the yield and active ingredient of saffron (*Crocus sativus* L.). – Journal of Saffron Research 10(1). Pp.64-83.
27. Dewir Y.H.; Alsadon A. 2022b. Effects of Nutrient Solution Electrical Conductivity on the Leaf Gas Exchange, Biochemical Stress Markers, Growth, Stigma Yield, and Daughter Corm Yield of Saffron in a Plant Factory. Horticulturae 2022, 8, 673. https://doi.org/10.3390/ horticulturae8080673
28. Dewir Y.H., Alsadon A., Ibrahim A., El-Mahrouk M. 2022a. Effects of growing substrate, mode of nutrient supply, and saffron corm size on flowering, growth, photosynthetic competence, and cormlet formation in hydroponics. Hort Technology, 32(2). Pp.234-240. https://doi.org/10.21273/HORTTECH04980-21
29. Esmaeilian Y., Amiri M. B. Tavassoli A., Caballero-Calvo A., Rodrigo-Comino J. 2022a. Replacing chemical fertilizers with organic and biological ones in transition to organic farming systems in saffron (*Crocus sativus*) cultivation. Chemosphere, 307 (Part 1):135537.
30. El-Mahrouk M.E., Dewir Y.H., El-Ramady H., Seliem M.K. 2023. Vegetative growth and productivity of potted *Crocus sativus* in different growing media. Horticulturae, 9(3):377. Pp.1-13. https://doi.org/10.3390/horticulturae9030377
31. Nodira K. Ruzmetova, Xurshidbek O. Abdullayev, Sodikjon X. Abdinazarov, Gayrat N. Juraev and Nortoji A. Khujamshukurov. 2024. Changes in Protein and Amino Acid Content of Saffron Flowers Depending on Fertilization. Int.J.Curr.Microbiol.App.Sci. 13(9): 56-67. https://doi.org/10.20546/ijcmas.2024.1309.00