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EFFECT OF BIOFERTILIZERS ON QUALITY OF SWEET CORN

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Abstract

Paper presents the effect of the Panoramix biofertilizer, whose composition consists of a combination of fungi (Trichoderma spp.) and bacteria (Bacillus spp.) on the quality of the edible part of sweet corn. The sweet corn crop was established in 2019, by sowing, and the seeds were treated with Panoramix, at a dose of 2 ml/kg seed. In this sense, two sweet corn hybrids were tested:`Basin $F_1$` and `Challenger $F_1$. The variants were organized as follows:`V_1- `Basin $F_1$`- untreated; V_2- `Basin $F_1$`- treated; V_3- `Challenger $F_1$`- untreated; V_4 -`Challenger $F_1$` - treated. The results regarding some the quality components, like TSS, reducing sugar, starch, carotene and antioxidant capacity confirmed the superiority of the application of the Panoramix biofertilizer compared to non-mycorrhizal variants. Among the tested hybrids, `Challenger $F_1$` recorded a better quality of sweet corn caryopses in the version treated with the micorryzal product. Based on the obtained results, it can be stated that the product Panoramix could be recommended as a promising sustainable approach to stimulate the quality of the sweet corn. Among the tested hybrids, `Challenger $F_1$` recorded a better quality of sweet corn caryopses in the version treated with the with the mycorrhizal product.

Key words: *Zea mays* var.*saccharata, mycorrhiza, production quality.*

INTRODUCTION

Sweet corn (*Zea mays* var. *saccharata*) is a vegetable grown mainly for human consumption, eaten fresh or processed. It is a rich an important source of fiber, minerals, vitamins, folic acid, amino acids, proteins, antioxidant compounds (polyphenols and carotenoids) and other phytochemicals with bioactive properties. There are numerous studies that confirm the presence of phenolic and flavonoid compounds in sweet corn. Among the predominant phenolic acids are ferulic and p-coumaric acid, but caffeic, syringic, vanillic and gallic acids have also been identified. Among flavonoids, the major compounds are kaempferol and quercetin (Das and Singh, 2016).

Sweet corn is a valuable source of carotenoids that have the property of protecting cells against oxidative stress (O'Hare et al., 2015). Beta carotene has an important role in supporting the immune system, in the process of cell specialization and metabolism of iron (Young and Woodside, 2001). Lutein and zeaxanthin are the major carotenoids found in sweet corn caryopses (Pacurar-Grecu et al., 2017; O'Hare et al., 2015; Junpatiw et al., 2013), known for their importance in maintaining eye health to protect ocular tissues from phototoxic damage (Bone et al., 2000).

In recent years, more and more intensive practices have been applied in agriculture that increase crop yields, practices with a negative impact on the environment. For increasing agricultural yield it must use rationally doses of fertilizer (Iancu et al., 2019). Therefore, sustainable and ecological technologies should be applied more often in agriculture to reduce the negative effects on the environment. From this point of view, biostimulators are a viable alternative to achieve this purpose. These products have many mechanisms of action, such as: stimulating seed germination, developing the root system, increasing resistance to diseases and pests, mitigating biotic and abiotic stress, increasing nutrient solubility or influencing photosynthetic activity. In the category of biostimulators are also included products based on mycorrhizas that contain fungi of the genus *Trichoderma* and bacteria of the genus *Bacillus* spp.

In addition, arbuscular mycorrhizal fungi (AMF) also function as a bioregulator with a role in the phytohormonal balance influencing various production quality parameters (Antunes, 2012). The most pronounced effects are observed in horticultural products with a high content of phytocompounds with beneficial effects on health (carotenoids, flavonoids, polyphenols), research being focused on the selection of AMF species that intensify secondary metabolism and lead to increased nutritional value. Rouphael et al., (2015), carry out a synthesis study in which they present the improving effects of arbuscular mycorrhiza on the growth and productivity of some horticultural crops.

Other microorganisms used as biostimulators are *Trichoderma* spp. fungi, being considered as the most important filamentous fungus in the biocontrol strategies of plant growth inducing resistance to the incidence of diseases. It controls a broad group of phytopathogens through mycoparasitism, using specialized attachment structures, enzymatic lysis and synthesis of secondary metabolites to compete for resources (Geraldine et al., 2013; Kohl et al., 2019). Different species of *Trichoderma* show a good adaptability, efficient reproductive capacity and the ability to survive in unfavorable growing conditions, but also rapid use of available nutrients from the soil. It is an active component in many biopesticides, biofertilizers and biostimulants, with beneficial effects on many horticultural crops: tomatoes (Molla, 2012) brassica plants (Poveda et al., 2019), lettuce (Avio et al., 2017), bean (Manzar et al., 2022), corn (Nascimento et al., 2020), etc.

Among the microorganisms with biostimulating properties of special interest is the bacteria which associated with the roots and the rhizosphere produce plant hormones (auxin, gibberellin and cytokinin), organic compounds and enzymes, antimicrobial compounds, fix nitrogen, increase the absorption of water and nutrients, induce systemic resistance, suppresses pathogens and ensures plant growth. These are called plant-growth-promoting bacteria-PGPB (Ruzzi and Aroca, 2015). Among these diverse microorganisms, *Bacillus* spp. have become some of the most attractive and effective agents of bacterial control for plant growth stimulation.

The interaction of plants with beneficial microorganisms can lead to a significant accumulation of secondary metabolites in the edible parts of plants, which are nutritionally valuable functional compounds, such as: ascorbic acid, phenolic compounds, terpenoids, carotenoids (Ganugi et al., 2021). Stimulation of secondary metabolism when applying biostimulators is also reported by other authors. In the study by Katsenios et al. (2022) that investigated the effectiveness of 10 strains of plant growth promoting bacteria on sweet corn crop, they observed that treatment with *Bacillus licheniformis* caused an increase in photosynthetic rate, transpiration rate and stomatal conductance during the cultivation period. Also, by using the Panoramix product (a mixture of *Bacillus* spp. and *Trichoderma* spp.) in the wheat culture, seed germination and the physiological processes involved in plant growth were improved (Ayed et al., 2022).

There are numerous claims regarding the effect on plant metabolism through the use of biofertilizer products that synergistically combine the beneficial effects of different species of *Trichoderma* and *Bacillus* spp. (Molla et al., 2012; Efthimiadou et al., 2020).

The use of beneficial microorganisms in agriculture, often referred to as microbial biostimulants, is gaining popularity in recent years as a sustainable approach to promote plant growth and productivity (Ganugi et al., 2021). El Fattah et al. (2023) report the positive effects of arbuscular mycorrhiza on the morphological and production characteristics of the sweet corn crop. In contrast, there is limited information in the literature regarding the effect of AMF on biochemical compounds in sweet corn. As a result, the research in this paper followed the effect of the application of Panoramix biostimulator on the nutritional quality of caryopses in two sweet corn hybrids.

MATERIALS AND METHODS

The biological material was represented by sweet corn hybrids: Basin F_1 and Challenger F_1. In this regard, the seed was treated with

Panoramix, a biological complex whose composition consists of a combination of fungi (*Trichoderma* spp.) and bacteria (*Bacillus* spp.) that promote plant growth and their resistance to various environmental factors. These microorganisms colonize the roots and protect the crop during the entire vegetation period ensuring the availability of nutrients more easily, such as nitrogen and phosphorus. The experimental model included four variants: V_1-`Basin $F_1$` untreated; V_2- `Basin $F_1$` treated; V_3-`Challenger $F_1$` untreated and V_4-`Challenger $F_1$` treated. The sweet corn crop was established in the third decade of April, in 2019, applying the technological sequences specific to this crop.

The biochemical determinations were carried out at technical maturity (ready for consumption), in the milk-wax phase of the caryopses and focused on the content of: SUS, reducing sugar, starch, vitamin C, carotene, total phenolic compounds and antioxidant activity.

Chemical analysis

Total soluble solids content (TSS) (%) was determined using a digital refractometer (Kruss Optronic DR 301-95) at 20°C.

The reducing sugars were extracted in distilled water (1:50 W/V), 60 minutes at 60˚C and determined by the colorimetric method at 540 nm with 3,5-dinitrosalicylic acid reagent using glucose as standard (Soare et al., 2019). The results were expressed in % fresh weight basis.

The starch content was determined by using Ewers polarimetric method (Soare et al., 2019). Starch from the ethanol-insoluble material is extracted into hot dilute hydrochloric acid. After having cooled, phosphotungstic acid is added to precipitate the proteins and the solution is filtered. The optical rotation of the filtrate is measured using a Carl Zeiss JENA polarimeter and the results were calculated with a specific optical rotation of the starch [α] D20˚ = 184.6˚. The results were expressed in % fresh weight (FW) basis.

Total carotenoid content was determined with the spectrophotometric method (Babeanu et al., 2016). For extraction of carotenoids 1 g fresh material was homogenized with 10 mL acetone. The acetone extract was mixed with 10 mL hexane, and then 25 mL water was added to separate carotene into the hexane layer. Absorbance at 450 nm was measured and total carotenoid content is calculate using a value of 2500 for the extinction coefficient (E1%) and expressed as mg/100 g FW.

Ascorbic acid was extracted in 2% hydrochloric acid, HCl; 5:50 w/v (Soare et al., 2018). The determination of ascorbic acid is performed from the supernatant with iodometric redox titration in which iodine reacts with ascorbic acid, oxidizing it to dehydroascorbic acid. The ascorbic acid content was expressed as mg/100 g FW.

The extracts for the determination of total phenolic content and antioxidant activity were prepared into 80% aqueous methanol (1: 10 w/v) at 24°C for 16 h.

Total phenolic compounds (TPC) content was determined colorimetric at 765 nm by using the Folin-Ciocalteu method (Babeanu et al., 2016) based on the oxidation of phenolic groups with phosphomolybdic and phosphotungstic acids. The total phenolic content (TPC) was calculated using a standard curve prepared using gallic acid and expressed as mg of gallic acid equivalents (GAE)/100 g FW.

Antioxidant activity is evaluated as 2, 2-diphenyl-1-picrylhydrazyl (DPPH) radical scavenging assay by colorimetric method (Soare et al., 2018). 2 mL of 0.075 mM DPPH methanolic solution was mixed with 0.1 mL extract and vortexed thoroughly. The absorbance of the mixtures was measured at 517 nm after 20 minutes. A blank reagent was used to study stability of DPPH over the test time. The percentage of DPPH radical scavenging activity of extracts was evaluated according to the formula: % scavenging = $[A_0-(A_1–A_S)]/ A_0]100$, where A_0 is the absorbance of DPPH alone, A_1 is the absorbance of DPPH + extract and A_S is the absorbance of the extract only. Trolox (T) was used as standards. The standard calibration curve was plotted as a function of the percentage of DPPH radical scavenging activity. The results were expressed as mmol Trolox equivalents (TE) per 100 g fresh weight (mmol TE/100 g FW).

The spectrophotometric measurements were performed with Evolution 600 UV - Vis spectrophotometer, Thermo Scientific, England with VISION PRO software. All determinations were performed in triplicate, and all results were calculated as mean.

The processing of the results was carried out according to the method of analysis of variance. The comparisons of means were calculated using the method of multiple comparisons, at a level of significance $P \leq 0.05$. Mean values on the same column indicated by different letters are statistically different.

RESULTS AND DISCUSSIONS

The result regarding the effect of the Panoramix biostimulator on the quality characteristics (TSS, reducing sugar, carotene, ascorbic acid, total phenols and antioxidant activity) of sweet corn caryopses are presented in Tables 1 and 2. Thus, TSS varied from 12.72% (V$_2$-`Basin F$_1$`) to 16.85% (V$_3$-`Challenger F$_1$`). From the recorded results, it can be seen that the reaction of the hybrids to the applied biostimulator is diverse. Application of the product caused an increase in TSS content only in `Challenger F$_1$`. Also, Efthimiadou et al. (2020) reported that through soil and foliar application of the PGPB biostimulator there was an increase in the content of soluble substances in corn seeds and crude fiber in the treated variants, and Nascimento et al. (2020) observed a significant increase in the amount of total soluble and dry substance on corn (*Zea mays*) in the biofertilized variants compared to the control.

The main attribute that makes sweet corn attractive to the consumer is the sweet taste determined by the sugar content. Sweet corn contains glucose, fructose and mostly sucrose. Soluble sugars in sweet corn contain 94.88 and 85% sucrose in genotypes *sh2*, *se* and *su* (Becerra Sanchez and Taylor, 2021), and glucose and fructose in smaller quatities.

In the present study, the reducing sugar in the corn caryopses varied from 1.89% (`Basin F$_1$`) to 3.16 % (`Challenger F$_1$`) (Table 1.). Comparing the hybrids between them, it is found that `Challenger F$_1$` recorded high values compared to `Basin F$_1$` for both variants, and regarding the influence of the treatment, there was an increase in the level of reducing sugar in both hybrids, in the treated variants. Thus, it can be said that sugar accumulation can be influenced by the hybrid, technology, environmental conditions and harvest time.

Our results are also supported by Bona et al., (2018) who showed the positive effect of applying AMP to the tomato crop, by increasing the concentration of sugar in the fruit, and by Molla et al. (2012) through biofertilization with BioF/compost (household/kitchen wastes composted by *Trichoderma harzianum* T22).

Table 1. The content of some quality indices in sweet corn

The specifics of the variants	TSS (%)	Reducing sugars (%)	Starch (%)
V$_1$- `Basin F$_1$`- untreated	13.21^{c}	1.89^{b}	14.28^{ns}
V$_2$- `Basin F$_1$`- treated	12.72^{d}	1.94^{b}	16.45 ^{ns}
V$_3$-`Challenger F$^1$` - untreated	16.85^{a}	2.98^{a}	15.06 ^{ns}
V$_4$- `Challenger F$_1$` -treated	16.24^{b}	3.16^{a}	13.66 ^{ns}
LSD ($P \leq 0.05$)	0.34	0.71	6.48

The starch content varied between 13.66% in (V$_4$) and 16.45% in (V$_2$) (Table 1). In the case of the `Basin F$_1$` hybrid, the starch content was higher in the treated variant compared to the untreated variant, while in the `Challenger F$_1$` hybrid, lower values were recorded in the case of the treated variant. From a statistical point of view, there are no significant differences between the variants. Some authors reported a variable content of starch in potatoes, influenced by the variety and the type of biofertilizer (Mystkowska, 2019). Also, Katsenios et al. (2022) who investigated the effect of some strains of PGPB (plant growth promoting bacteria), on the quality of sweet corn, reported that only certain strains such as *B. mojavensis*, *B. subtilis* and *B. pumilus* influenced grain quality (protein and fiber content), and other strains positively influenced production. These researches are useful to highlight the different influence of mycorrhizal fungi depending on the strain.

The content of ascorbic acid in sweet corn varied between 6.48 mg/100 g FW in (V$_1$) and 7.79 mg/100 g FW in (V$_4$). Comparing the two hybrids, significant differences are found between the treated and the untreated variants or between the same variants. In both hybrids, the treatment with biostimulator led to an increase in the ascorbic acid content. Similar observations were also reported by Apostol et al., (2022) who found a significant increase in the culture of long pepper fertilized with mycorrhizal fungi compared to the unfertilized version or the one fertilized with fulvic acids. José David et al., (2018) showed that inoculation with strains of *Phyllobacterium* and *Rhizobium* is a good agronomic practice, which improves the content of vitamin C and other bioactive compounds in strawberries, with beneficial effects on human health.

Secondary metabolites of plants are considered key bioactive compounds for a healthy diet (Avio et al., 2017).

Regarding the content of total carotene in sweet corn, the higher values were recorded in the treated variants 0.89 mg/100 g FW at V_2 and 0.98 mg/100 g FW at V_4 respectively. In both hybrids, the treatment does not induce a significant increase in the total content of carotenoids. The effect of biostimulators with AM and PGPB fungi used in combination was also studied on the nutritional quality of tomatoes, indicating an increase in the concentration of carotene in fruits (Bona et al., 2018). Some studies have shown the contradictory effect on the concentration of carotene under the influence of mycorrhizal inoculation. Horváth et al. (2020) in their study they evaluated of mycorrhizal product containing AM mixture on tomato culture, in conditions of insufficient irrigation and showed a decrease in total carotene content. It can be appreciated that the variability of the results is due to the influence of different inoculated mycorrhizal fungi.

Table 2. Antioxidant activity in sweet corn

The specifics of the variants	Ascorbic acid (mg/100 g FW)	Total carotenoids (mg/100g FW)	TPC (mg GAE/g FW)	AA (DPPH (mmol TE/100g)
V_1-\`Basin $F_1$\`- untreated	6.48^{d}	0.77^{ns}	54.48^{b}	141.46^{d}
V_2-\`Basin $F_1$\`- treated	6.71^{c}	0.89^{ns}	57.19^{a}	165.31^{b}
V_{3-}\`Challenger $F_1$\`- untreated	7.47^{b}	0.83^{ns}	52.71^{b}	155.14^{cd}
V_4\`Challenger $F_1$\`-treated	7.79^{a}	0.98^{ns}	57.31^{a}	178.05^{a}
LSD ($P \leq 0.05$)	0.32	0.30	3.15	20.62

The content of phenolic compounds varies with the hybrid and with the applied treatment. In the case of the \`Basin $F_1$\` hybrid, the Panoramix treatment increases the TPC content from 54.48 mg GAE/100 g FW to 57.09 mg GAE/100g FW and in the case of the \`Challenger $F_1$\` hybrid from 52.71 to 57.63 mg GAE/ 100 g FW.

Recent studies have shown positive effects of treatment with microbial biostimulators on TPC content in different horticultural plants, confirming the increase in quality and nutritional value (Ganugi et al., 2021). Thus, a significant increase in antioxidant activity and phenolic substances was observed in lettuce plants inoculated with *Rhizoglomus irregulare* compared to non-inoculated plants (Avio et al., 2017).

The antioxidant activity varies both with the hybrid and with the applied treatment (table 2). The antioxidant activity against the DPPH radical varies between 141.46 mmol TE/100 g (V_1) and 178.05 mmol TE/100 g (V_4), finding in both hybrids that the treatment with the Panoramix increased the antioxidant activity by 16.85% (\`Basin $F_1$\`) and 14.76% (\`Challenger $F_1$\`).

Among the compounds analyzed in this study, carotenoid compounds, ascorbic acid and polyphenolic compounds show strong antioxidant action. The treatment with biostimulators that induced in both hybrids the increase in the content of these compounds also induced the increase in antioxidant activity. Recent research has shown that free radicals play a causal role in the development of many diseases (inflammation, cardiovascular disease, cancer, diabetes, neurodegenerative disease, atherosclerosis) and aging processes. Sweet corn, having numerous constituents with free radical scavenging capacity, can be considered a valuable source of exogenous antioxidants important in preventing and treating diseases involving free radicals.

All investigated biochemical indices (except starch and carotene content) increase in the case of variants treated with the Panoramix biostimulator compared to the control variant. The Panoramix product stood out as a very efficient biostimulator in wheat culture, improving germination and the physiological processes involved in plant growth (Ayed et al., 2022). The interaction of plants with beneficial microorganisms can lead in the edible parts of plants to a significant accumulation of secondary metabolites which are nutritionally valuable functional compounds. Food quality modulation can be achieved by applying microbial biostimulators that induce accumulation of antioxidant compounds such as: ascorbic acid, phenolic compounds, terpenoids, carotenoids (Ganugi et al., 2021). For key quality attributes, the values may vary and significantly influenced by the hybrid as well (Soare et al., 2019).

CONCLUSIONS

The results of the study show that the application of the Panoramix biostimulator obtained from a mixture of fungi (*Trichoderma* spp.) and bacteria (*Bacillus* spp.) had a different influence at sweet corn, depending on the hybrid and the investigated biochemical indicators. Its application determined the accumulation of total soluble solids, sugar, ascorbic acid, total phenolic and antioxidant activity in variants treated with the Panoramix biostimulator compared to the control variant. Among the tested hybrids, `Challenger $F_1$` recorded a better quality of sweet corn caryopses in the version treated with the Panoramix produc.

REFERENCES

Apostol, D.F., Dinu, M., Dumitru, M.G., Maracineanu, L.C., Josceanu, A.M., & Giugea, N. (2022). Influence of fertilization with *Trichoderma* atroviride and fulvic acids upon the nutritive vonstituents in long pepper fruits. UPB *Scientific Bulletin, Series B: Chemistry and Materials Science*, 84(1), 84-98.

Avio, L., Sbrana, C., Giovannetti, M., & Frassinetti, S. (2017). Arbuscular mycorrhizal fungi affect total phenolics content and antioxidant activity in leaves of oak leaf lettuce varieties. *Scientia Horticulturae*, 224, 265-271.

Ayed, S., Bouhaouel, I., Jebari, H., & Hamada W. (2022). Use of Biostimulants: Towards Sustainable Approach to Enhance Durum Wheat Performances. *Plants,* 11, 133.

Babeanu, C., Soare, R., & Dinu, M. (2016). Ascorbic acid, total phenolic, total carotenoid content and antioxidant activity in three carrot cultivars, *Annals of the University of Craiova, The Chemistry Series,* XLIII, 35-41.

Becerra-Sanchez, F., & Taylor, G. (2021). Reducing post-harvest losses and improving quality in sweet corn (*Zea mays* L.): Challenges and solutions for less food waste and improved food security. *Food Energy Securety*, 10, e277.

Bona, E., Todeschini, V., Cantamessa, S., Cesaro, P., Copetta A., Lingua G., Gamalero E., Berta G., & Massa N. (2018). Combined bacterial and mycorrhizal inocula improve tomato quality at reduced fertilization, *Scientia Horticulturae*, 234, 160-165.

Bone, R.A., Landrum, J.T., Dixon, Z., Chen, Y. & Llerena, C.M. (2000). Lutein and zeaxanthin in the eyes; serum and diet of human subjects. *Experimental Eye Research*, 71 (3), 239-245.

Da Cruz, L.L., Goncalves, G.M.B., de Lima, G.L., Pereira, S.M. F., Carlos, L. A., Vivas, M., Pereira, M.G., & De Oliveira, D.B. (2022). Phenolic compounds, carotenoids and antioxidant activity in a the 'UENF SD 08' super-sweet corn hybrid. *Pesquisa Agropecuária Brasileira*, v.57, e02663.

Das, A.K., & Singh, V. (2016). Antioxidative free and bound phenolic constituents in botanical fractions of Indian specialty maize (*Zea mays* L.) genotypes. *Food Chemstry*, 201, 298–306.

El Fattah, D.A.A., Maze, M., Ali, B.A.A., & Awed, N.M. (2023). Role of mycorrhizae in enhancing the economic revenue of water and phosphorus use efficiency in sweet corn (*Zea mays* L. var. *saccharata*) plants. *Journal of the Saudi Society of Agricultural Sciences*, 22(3), 174-186.

Ganugi, P., Martinelli, E., & Lucini, L. (2021). Microbial biostimulants as a sustainable approach to improve the functional quality in plant-based foods: a review, *Current Opinion in Food Science*, 41, 217–223.

Geraldine, A.M., Lopes, F.A.C., Carvalho, D.D.C., Barbosa, E.T., Rodrigues, A.F., Brandao, R.S., Ulhoa, C.J., & Junior, M.L. (2013). Cell wall-degrading enzymes and parasitism of sclerotia are key factors on field biocontrol of white mold by *Trichoderma* spp. *Biological Control*, 67(3), 308–316.

Iancu, P., Păniță, O., & Soare, M. (2019). Evaluation of Drought Tolerance Indices and Nitrogen Fertilization for Some Groundnut (*Arachis hypogaea* L.) Genotypes. *Agricultural Science*; 1(1), 18-29.

José David, F.F., Velázquez, E., García-Fraile, P., González-AF., Silva, L.R., & Rivas, R. (2018). *Rhizobium* and *Phyllobacterium bacterial* inoculants increase bioactive compounds and quality of strawberries cultivated in field conditions. *Food Research International*, 111, 416-422.

Junpatiw, A., Lertrat, K., Lomthaisong, K., & Tangwongchai, R. (2013). Effects of steaming, boiling and frozen storage on carotenoid contents of various sweet corn cultivars. *International Food Research Journal*, 20(5), 2219-2225.

Katsenios, N., Andreou, V., Sparangis, P., Djordjevic, N., Giannoglou, M., Chanioti, S., Kasimatis, C.N., Kakabouki, I., Leonidakis, D., Danalatos, N., Katsaros, G., & Efthimiadou, A. (2022). Assessment of plant growth promoting bacteria strains on growth, yield and quality of sweet corn. *Scientific Reports,* 12, 11598.

Kohl, J., Kolnaar, R., & Ravensberg, W.J. (2019). Mode of action of microbial biological control agents against plant diseases: relevance beyond efficacy. *Frontiers Plant Sciences*, 10, 845.

Manzar, N., Kashyap, A.S., Goutam, R.S., Rajawat, M.V.S., Sharma, P.K., Sharma, S.K., & Singh, H.V. (2022). *Trichoderma*: Advent of Versatile Biocontrol Agent, Its Secrets and Insights into Mechanism of Biocontrol Potential. *Sustainabilit,* 14, 12786.

Mystkowska I.T. (2019). Biostimulators as a factor affecting the dry matter yield and starch content of edible potato tuber. *Acta Agrophisica*, 26(1), 37-45.

Molla, A.H., Manjurul Haque, M., Amdadul Haque, M. Ilias GNM. (2012). *Trichoderma*-Enriched Biofertilizer Enhances Production and Nutritional Quality of Tomato (*Lycopersicon esculentum* Mill.) and Minimizes NPK Fertilizer Use. *Agricultural Research* 1, 265–272.

Nascimento, M.A., Maciel, A.M., Silva, J.B.G., Mendonça, H.V., Romário de Paula, V., & Hoteino, M.V. (2020). Biofertilizer Application on Corn (*Zea mays*) Increases the Productivity and Quality of the Crop Without Causing Environmental Damage. *Water, Air Soil Pollution,* 231- 414.

O'Hare, T.J., Fanning, K.J., & Martin, I.F. (2015). Zeaxanthin biofortification of sweet-corn and factors affecting zeaxanthin accumulation and colour change. *Archives of Biochemistry and Biophysics*, 572,184-187.

Pacurar (Grecu), L., Apahidean, A.I., Hoza, G., Dinu, M., Soare, R., Apahidean, M., & Has, V. (2018). Estimation of variability parameters of some qualitatives components at a set of sweet corn lines from Turda Agricultural Research Station. *Scientific Papers. Series B. Horticulture*, 62, 345-350.

Poveda, J., Hermosa, R., Monte, E., & Nicolás, C. (2019). The *Trichoderma harzianum* Kelch protein ThKEL1 plays a key role in root colonization and the induction of systemic defense in Brassicaceae plants. *Frontiers in Plant Science*, 10, 1478.

Rouphael, Y., Franken, P., Schneider, C., Schwarz, D., Giovannetti, M., Agnolucci, M., De Pascale, S., Bonini, P., & Colla, G. (2015). Arbuscular mycorrhizal fungi act as biostimulants in horticultural crops, *Scientia Horticulturae*, 196, 91–108.

Ruzzi, M., & Aroca, R. (2015). Plant growth-promoting rhizobacteria act as biostimulants in horticulture. *Scientia Horticulturae*, 196, 124–134.

Soare, R., Dinu, M., Babeanu, C., & Soare, M. (2018). Influence of alternative technological sequences on the quality of melon production. *Scientific Papers. Series B, Horticulture*, 62, 477-482.

Soare, R., Dinu, M., Hoza, G., Bonea, D., Babeanu, C., & Soare, M. (2019). The influence of the hybrid and the sowing period on the production of sweet corn, *Scientific Papers. Series B, Horticulture*, 63, 391-397.

Young, I.S., & Woodside, J.V. (2001). Antioxidants in health and disease*. Journal of Clinical Pathology*, 54(3), 176-186.

Zang, R.F., Huang, L., Deng, Y.Y., Chi, J.W., Zhang, Y., Wei, Z.C., & Zhang, M.W. (2017). Phenolic content and antioxidant activity of eight representative sweet corn varieties grown in South China. *International Journal Food Properties*, 20, 3043–3055.

Zhu, S., Mount, J.R., & Collins, J.L. (1992). Sugar and soluble solids changes in refrigerated sweet corn (*Zea mays* L). *Journal of Food Science*, 57 (2), 454-457.