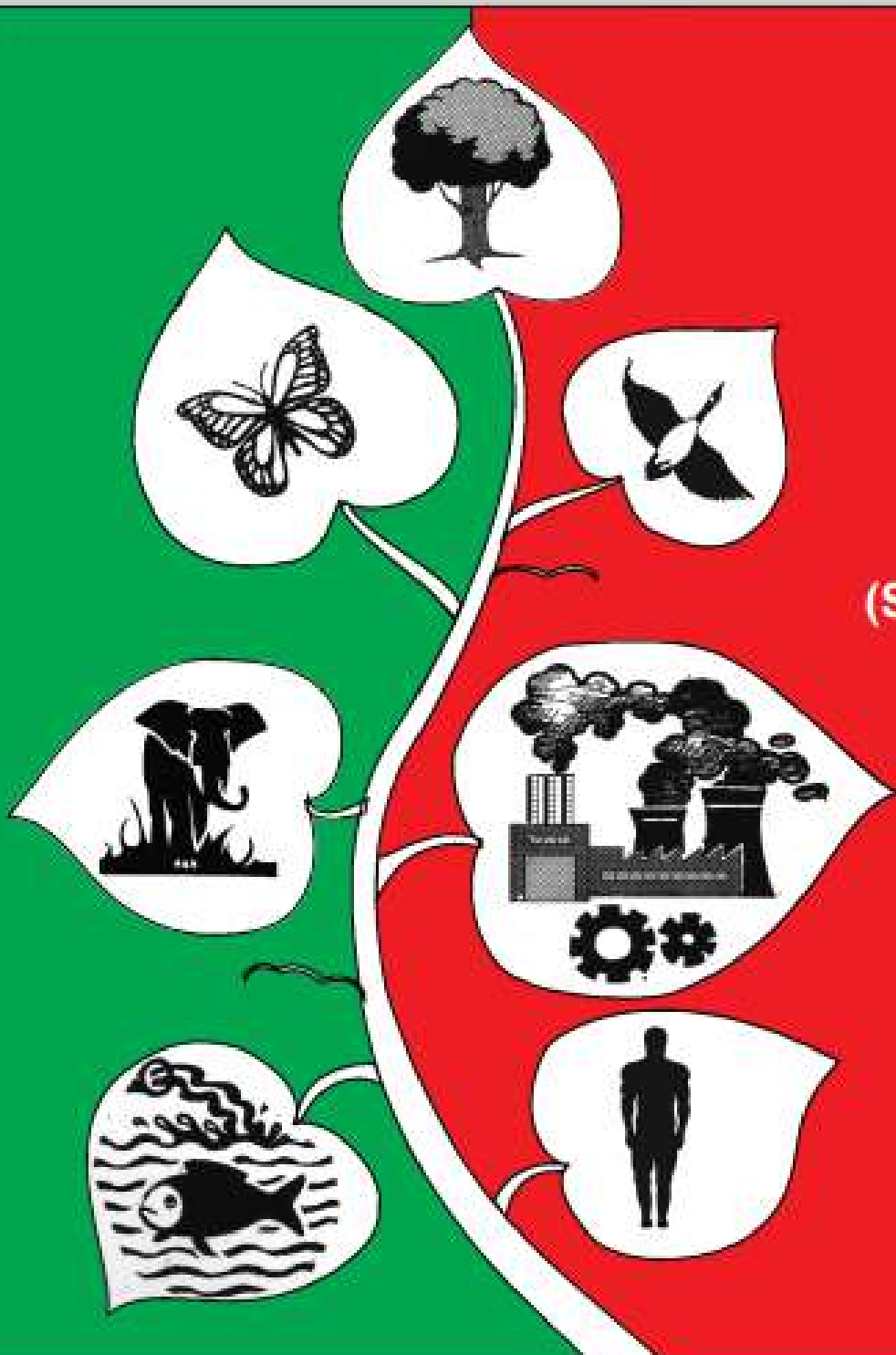


QUARTERLY INTERNATIONAL JOURNAL

ECOLOGY

ENVIRONMENT & CONSERVATION

ISSN 0971-765 X



(Supplement Issue)
August, 2022



EM INTERNATIONAL

ECOLOGY, ENVIRONMENT AND CONSERVATION

VOL. 28 (August Suppl. Issue) : 2022

CONTENTS

- S1–S8 Population dynamics of *Pseudophoxinus callensis* (Guichenot, 1850) (Cyprinidae) in the National Park of El Kala (Northeast Algeria)
—Mohamed Faouzi Samar, Mahieddine Boumendjel, Mohamed Lamine Khireddine, Abdallah Metai and Abderrafik Meddour
- S9–S13 Studies on effect of betel nu extract solution on mortality of armyworm *Areca* (*Spodoptera litura* F.) on lettuce (*Lactuca sativa* L.) plants
—Akhmad Rizali, Noor Laili Aziza and Hamsyin
- S14–S19 Effect of Waterlogging on the Morphological Characters of Mutant Sugarcane (*Saccharum officinarum* L.) in the Early Stage
—Dwi Mai A.I. Buqori, Sholeh Avivi, Sri Hartatik, Muhammad Ubaidillah, Tri Handoyo and Parawita D.
- S20–S26 Features of the soybean photosynthetic productivity indicators formation depending on the foliar nutrition
—Bondarenko V., Havrylianchik R., Ovcharuk O., Pantsyreva H., Krusheknyskiy V., Tkach O. and Niemec M.
- S27–S35 Sub Surface Structure Modelling Area Around Subdistrict Gantiwarno, District Klaten using by Gravity Method
—M. Irham Nurwidyanto, Tony Yulianto, Gatot Yulianto and Sugeng Widada
- S36–S44 Efficacy of *Rauvolfia tetraphylla* Leaf extracts against the Vector of Lymphatic *Filariasis culex quinquefasciatus*
—Radhakrishna S. Pandit and Kishor D Raut
- S45–S50 Characterisation of Laboratory Wastewater for Planning Wastewater Treatment Plants in a University Campus in Indonesia
—E. Novita, I. Andriyani, E. S. Hartiningsih and H.A. Pradana
- S51–S58 Heavy metal contamination of *Diplodus vulgaris* (Sparidae) in the Gulf of Annaba (North-eastern Algeria)
—Feknous Nesrine, Boumendjel Mahieddine, Bouchecker Abdenour, Nakib Lydia, Boulehbel Anis, Briki Ines, Boumendjel Amel and Messarah Mahfoud
- S59–S69 Vulnerability assessment of protected area to forest landscape restoration and climate change mitigation: A case study from Vietnam
—Dang Cuong Nguyen, Duc Chinh Pham and Thi Anh Tuyet Truong
- S70–S80 Sedimentological, mineralogical and geochemical investigation of Chichaoua's bassin depot system: potential origin and provenance
—Fathallah Fatima-Ezzahra, Algouti Ahmed and Algouti Abdellah
- S81–S86 Impact of Haematological Parameters of *Labeo rohita* (HAMILTON, 1882) Exposed to Pesticide of Profenofos
—Jebashiny N.T. and Lakshmanan S.
- S87–S92 The Sacred Flora of India: A Case for Biodiversity Conservation
—Niraj Kumar Singh
- S93–S97 Performance of Food Processing Industry in India
—A. Sachindra Babu, Y. Nagaraju and A.V. Manjunatha
- S98–S103 Evaluation of long duration Promising Rice Genotypes for Resistance to Stem Borer, *Scirpophaga incertulas* (Walker) and gall Midge, *Orseolia oryzae* (Wood-Mason)
—I. Paramasiva, Ch Sreelakshmi, U. Vineetha and P. Rajasekhar
- S104–S107 Pattern of energy utilization of tractor-implement system during field operations in Indo-Gangetic Plain
—Nishanth M. Stanly, Indramani, Roafahmadpararray, Rajeev Kumar, Pramod Kumar Sahoo and Satish Devaram Lande
- S108–S113 Assessment of Ambient Air quality in Industrial Cluster at Paradip (India) based on Air Quality Index (AQI)
—Maniklal Ghosh, Paresh Nath Chatterjee, Malay Kumar Pradhan and Kitty Salony

- S114–S120 Microencapsulation of Vetiver Essential Oil using Complex Coacervation Technique
—*Shalini Rukhaya, Neelam M. Rose and Saroj Yadav*
- S121–S125 Promising rice establishment methods and N management for rice-greengram system
—*A. Upendra Rao, K. Madhu Kumar, V. Visalakashmi, S. Govinda Rao and N. Hari Satyanarayana*
- S126–S132 Standardization of used engine oil concentration for analysis of biodegradation potential of *Pleurotus* sp. MP 5 MCC 1815 - A Scanning Electron Microscope based analysis
—*Madhavi Tiwari, Ashish Saraf and Akhilesh Kumar Pandey*
- S133–S138 Limnological Studies of Water Column Properties of Kuntbhoyag Lake, Mandi District Himachal Pradesh India
—*Kapil Dev and M. R. Sharma*
- S139–S150 Synergism of Beneficial Microbes Helps to Rejuvenate Flood and Landslide Affected Soils for Sustainable Agriculture – A Review
—*A Haseena and K Surendra Gopal*
- S151–S156 eFlora: Future of Plant Taxonomy and Conservation
—*Anuradha Sharma, Rajiv Sharma, Chetan Pandey and Vivek Chopra*
- S157–S162 Water Quality in Relation to Phytoplankton Diversity of Gautam Kund, Dehradun (Uttarakhand), India
—*Dhyal Singh, N. Kebosenti Chang and Ashu Chaudhary*
- S163–S170 Determination of water quality characteristics of river Yamuna at Baghpat, Uttar Pradesh, India during 2019-2021
—*Priya Panwar and Sushil Kumar Upadhyay*
- S171–S176 Evaluation of water quality using physico-chemical parameters of Riverine Areas of Baddi (H.P), India
—*Vandana Sethi, Yogesh Kumar Walia, Vishal Rana and Divya Gautam*
- S177–S181 Effect of nitrogen and phosphorus fertilizers on growth and quality of high quality protein maize (*Zea mays* L.) to under South Saurashtra agroclimatic zone of Gujarat
—*Shiv Prasad Daroga, G.S. Vala, Sheeshpal Choudhary, Mahendra Choudhary and Chotu Ram Hakla*
- S182–S188 Ecological Productivity Studies of the Dominant Aquatic Macrophytes in Kapla Beel, Assam North East India
—*Upen Deka, Upasana Borthakur and Shreemoyee Phukan*
- S189–S193 Productivity, Nutrient Content and Uptake of Wheat (*Triticum aestivum* L.) as Influenced by Integration of Organic, Inorganic and Biofertilizers Nutrient Sources
—*Sandeep Kumar Verma, A.S. Yadav, Raghvendra Singh, Ankit Kumar Tiwari and Aneeta Yadav*
- S194–S200 Impact of patch size on tree biomass and carbon stock from a tropical dry forest of West Bengal, India
—*S.S. Manna*
- S201–S207 Negative impact of new invasive species *Dolichandria unguis-cati* on the flora in Balh valley of Mandi district, India
—*Suman Rawat*
- S208–S211 Factors Responsible for changing trends of Bio- diversity in Eastern Ghats of Tamil Nadu
—*Kanimozhi R., P. Balasubramaniam and Mohanraj V.*
- S212–S215 Studies on length-weight relationship and relative condition factor of *Garra langlungensis* (Ezung, Shangningam and Pankaj, 2021) from Langlung River, Nagaland, India
—*Sophiya Ezung and Pranay Punj Pankaj*
- S216–S225 Diversity of Bryophytes in India – Special Reference to North-East India
—*Munmi Borkataky, Toslima Nasrin and Dimonjyoti Bora*
- S226–S232 Constraints being faced by sojat goat rearers in Pali and Jalore districts of Rajasthan, India
—*Bagri D.K., L. Gupta, D.L. Bagdi and G.K. Bagri*
- S233–S237 Vegetation Change Detection using Remote Sensing and GIS, 2001-2021 – A Case Study of Nashik City, Maharashtra
—*P. M. Nalawade, B. L. Gadakh and Kadam Amol B*
- S238–S242 Indian Legal Regime for the Protection of Trees
—*Manoj Kumar Aggerwal and Meenu Gupta*

- S243–S246 Method for Separation and Detection of Gold Sulphide from Banded Magnetite Quartzite (BMQ) of Goa
—*Sujata Dabolkar and Nandkumar Kamat*
- S247–S258 Differential Uses Pattern of Menstrual Material among Non-Tribal and Tribal Community in selected rural areas of West Bengal: A case study
—*Lopamudra Ganguly and Lakshminarayan Satpati*
- S259–S265 *Ageratum conyzoides* L.: *In vitro* antimicrobial, antioxidant and phytochemical study
—*Dipika Rajput, L.R. Saikia, Mummi Borkataky and Sandeepa Agarwalla*
- S266–S269 Eco-friendly cucumber production approach under protected cultivation
—*K.S. Rajawat, K.D. Ameta R.A. Kaushik and Mohan Singh*
- S270–S275 Phytoplankton Groups in the Estuarine Mangrove Creeks of Edakochi (Kerala), Southwest Coast of India: A Preliminary Study
—*Davood Nihal, Aiswariya Ghosh K.A., Naseem N.M. and Prabhakaran M.P.*
- S276–S281 Assessment of Drinking Water Quality of Bhavani River in Tamil Nadu, India
—*K. Ramah, R. Premchand, K. Sivakumar and M. Tilak*
- S282–S290 Molecular Identification and Phylogenetic Analysis of Some Common Beetles (Coleoptera) of Jammu Region, India Using DNA Barcoding
—*Sunali Bandral, Charul, Vikas Dogra, Mahender Singh, Mohd Feroz and Rakesh K. Panjaliya*
- S291–S296 Monitoring decadal changes in the Khudia DAM in the Central Indian State of Chhattisgarh through the application of Remote Sensing and GIS
—*Anupama Mahato*
- S297–S304 Quality assessment of groundwater quality parameters and their correlation with industrial pollution near the catchment area of Kothari River, Bhilwara (Rajasthan, India)
—*Ranjeet Jagariya*
- S305–S314 Assessment of Water Quality Indices of Heavy Metal Pollution in Jojari River (Jodhpur) using Multivariate Statistics
—*Vandana Kachhwaha, Garima Sharma, Priya Tanwar and Pallavi Mishra*
- S315–S318 Impact of Kishenganga Hydroelectric Project on Susceptibility and vulnerability of Brooder population of different fish species of the Kishenganga river in Kashmir (India)
—*Nasrul Amin, Salma Khan and Mohammad Farooq Mir*
- S319–S323 Standardization of Growing Media for Palak (*Beta vulgaris* var. *bengalensis*) var. Arka Anupama under Shade Net Conditions
—*Gopu, B., P. Mathankumar, R. Kumaresh and C. Kanimozhi*
- S324–S331 Challenges toward sustainability and role of Pandemic to Trigger it: A mini-review
—*Arpita Ghosh*
- S332–S336 Assessment of Morphological Diversity and physico-chemical characterization of *Elaeagnus latifolia* under different agro-ecological system in East Sikkim
—*Bijoy Gurung, Sujata Upadhyay, Laxuman Sharma and Obadiya Rai*
- S337–S340 Efficient role of rice associated Plant growth promoting bacteria
—*Diksha Kumari, Bishun Deo Prasad, Padmanabh Dwivedi and Sangita Sahni*
- S341–S344 Implementation of Small-Scale Biogas Plant in a Dairy Cattle Farm
—*Purabi Kaushik, J. Saharia, B.N. Bhattacharyya, D.C. Mili and D. Kalita*
- S345–S349 Cost Economics of Tractor Drawn On-farm Mobile Turmeric Steam Boiler
—*R. Swamy, R. Jayaprakash, M. Sridhar, B. Balaji Naik and S. Naveen Kumar*
- S350–S354 Allelopathic Interference of Weeds on Rice Germination
—*P.N. Dongre and Balram Prasad Yadav*
- S355–S362 Synergistic potential of microorganisms (bio-fertilizer) on growth performance of *Meliadubia*
—*A. Muthu Kumar and Sandhya G.M.*
- S363–S369 Study of Heterosis for Yield and Grain Quality Traits in Barley (*Hordeum vulgare* L.)
—*B.S. Meena, A. Dashora, N.S. Dodiya, Dinesh Kumar and R.P.S. Verma*
- S370–S375 Tree Root Dynamics: An Essential Tool to Combat Root Competition in Agroforestry
—*Y. Kumar, S. Manojkumar and L. Behera*

- S376–S378 Trend in Particulate air pollutants in Visakhapatnam city for 2018-2020: A case study
—Kavitha Chandu
- S379–S385 A Critical Analysis on Legal Awareness of Farm Based Agri-input Entrepreneurs on Agri Enterprises in Central Telangana Region
—B. Srishailam, B. Jirli and K. Raghavendra Chowdary
- S386–S390 Evaluation of degradation potential of Free cell & Immobilized cell using Shake flask technique and lab scale Bioreactor technique for remediation of Nitroaromatics in aqueous phase
—Meenu Sharma
- S391–S402 Ecological Changes in Ancient India
—Rakesh
- S403–S405 Reassessing the Association Between Economic Growth and Environment: An Indian Case
—Arnob Paul
- S406–S413 Exploring the Probiotic and Plant Growth Promoting Potential of Endophytic Bacteria Isolated from the Vegetable Crop Bhendi *Abelmoschus esculentus*
—D. Baskaran, S. Benazir Begum, J. Jenifer Annis Christy, B. R. Harisma and R.M. Murugappan
- S414–S416 Enhanced Pineapple Production in Nagaland: Impact of Soil and Rainfall
—Amod Sharma, B.K. Chaturvedi, S.C. Sharma and P.K. Sharma
- S417–S424 Fabaceous medicinal plants used in tribal medicine in the Eastern Ghats of Peninsular India -A review
—P. Seetharamu, V. Sivakumar, A.C. Polaiah and D. Sekhar
- S425–S432 Time Budget and Activity Pattern of Capped Langur (*Trachypithecus pileatus*) in Barail Wildlife Sanctuary, Assam, India
—Rofik Ahmed Barbhuiya, Nazimur Rahman Talukdar and Parthankar Choudhury
- S433–S436 Biochemical and Yield Performance of Strawberry Cultivars Grown Under Poly tunnel
—Ravi Kondle, Amit Kotiyal and Babita Bhangotra
- S437–S446 Assessment of Groundwater Quality and its Spatial Variability for Drinking Use in Northeastern Karnataka, India
—Basavaraja D., J.B. Kambale, S.L. Arunkumar and M. Lingadevaru
- S447–S454 Effect of Replacement of Fish Meal by Roasted Guar Korma on Growth Performance of *Puntius ticto*
—H.J. Dhimmar, S.R. Lende, D.R. Vadher, J.N. Mevada, S.R. Vala and K.M. Jora
- S455–S458 Status of bacterial blight disease in major clusterbean growing districts of Rajasthan, India
—Anita Jat, P.S. Shekhawat and K.K. Saini
- S459–S462 Study of tumbled snakes in open wells, a nightmare for snakes in western Maharashtra
—Chittora R.K., Jadhav A.S. Upreti N.C. and Sutar K.V.
- S463–S469 Eco-Friendly customer engagement Practices in hotels: A Qualitative Study
—Shabir Ahmad Dar, Parvinder Kour and Asra Zahoor Wani
- S470–S479 Impact of certain granular and foliar insecticides on beneficial fauna in rice ecosystem
—D. Bhavana, N.R.G. Varma, S. Malathi, R. Shravan Kumar and T. Kiran Babu
- S480–S489 The extent of traffic congestion in Guwahati, India: A multi index analysis
—Masum Ahmed and Daisy Das
- S490–S495 Competencies Required for Environmental Practicing Fast Food Industry
—Mohammad Shafiq Ur Rehman Dr. Sanjeeb Pal and Syed Aasif Bukahri
- S496–S499 Classification of LEA proteins using Support Vector Machine Algorithm
—S. Mahalakshmi, R. Pangayar Selvi, V. Anandhi and N. Bharathi
- S500–S508 Assessment of Avian Biodiversity and Bird strikes to Aircrafts at Bacha Khan International Airport, Peshawar KP, Pakistan
—Arz Muhammad Umrani, Ahmad Zamir, Umair Safdar, Mamoona Wali Khan and Sohaib Ahmed
- S509–S513 Sole carbon source utilization (SCSU) pattern of nodule forming rhizobia of *Sesbania* species
—Kuldeep Singh, Rajesh Gera, Nidhi Sharma, Jagdish Parshad, Sushil Kumar Singh and Anil Kumar

Features of the soybean photosynthetic productivity indicators formation depending on the foliar nutrition

Bondarenko V.¹, Havrylianchik R.¹, Ovcharuk O.², Pansyryeva H.^{3*}, Krusheknyckiy V.², Tkach O.¹ and Niemec M.⁴

¹State Agrarian and Engineering University in Podilia, Shevchenka Str., Kamianets-Podilskyi, Ukraine, 32316

²National University of Life and Environmental Sciences of Ukraine, Henerala Rodimtseva Str.19 Building 1, Kyiv, Ukraine, 03041

³Vinnytsia National Agrarian University, 3, Soniachna Str., Vinnytsia, Ukraine, 21008

⁴Agricultural University of Kraków, Al. Mickiewicza Str., Krakow, Poland, 21 31-120

(Received 23 November, 2021; Accepted 11 January, 2022)

ABSTRACT

The three-year research findings prove that foliar nutrition with trace elements influences the dynamics of leaf surface formation, dry matter accumulation, and soybean photosynthetic net productivity under the Western Forest-Steppe conditions of Ukraine. It was found out that foliar nutrition with the particular trace elements could enlarge the soybean leaf surface area, chlorophyll content and dry matter yield. During the experimental studies, a positive effect on increasing the leaf surface area in soybean crops during the end of flowering was found in the variants where copper, iron and molybdenum-containing fertilizer were applied. The leaf surface area in the variant where copper was applied reached 46.3 thousand m²ha, which confirms the importance of copper in the formation of sugars and protein, direct participation in the process of photosynthesis. On the basis of the conducted researches it is established that in general on the amount of chlorophyll in soybean leaves foliar feeding has a significant effect. The average chlorophyll content in soybean leaves was 1.10 mg⁻² g of raw weight. The dynamics of dry matter by phases of growth and development of soybeans is established. Soybean produced the maximum amount of dry matter during grain ripening. Thus, 7.59 t⁻¹ ha of dry matter was formed during the control.

Key words: Soybean, Foliar nutrition, Trace elements, Growing technology, Leaf surface, Dry matter.

Introduction

Photosynthesis is the basis for the yield organic matter formation. Therefore, the key task of the soybean growing technology is to create optimal conditions for photosynthetic mechanism formation and functioning that will provide its high productivity. Photosynthesis and nitrogen fixation are the most important processes in the life of legumes. Agrotechnologies aimed at ensuring the effective

use of environmental factors necessary for plants are mainly subordinated to the regulation of these processes. There is a close correlation between the rate of assimilation of headlights by plants and crop productivity.

It is known that the photosynthesis intensity considerably depends on the plant nutrient system. The point of the positive effect of mineral nutrition is that the plant photosynthetic productivity rises (Vdovenko *et al.*, 2018). The soybean photosynthetic

mechanism continuously changes from the moment of rising to collection and is at its highest point during the crop «budding-blowing» period. The bigger the leaf surface area of the best soybean density is, the higher the photosynthetic potential per unit of the area (Yanovych *et al.*, 2018 a). Trace elements have a positive effect on the leaf surface area enlargement, photosynthetic net productivity and photosynthetic potential increase. The yield correlates with the soybean photosynthetic net productivity. Foliar nutrition with trace elements considerably influences the photosynthetic net productivity. As Pantsyreva (2019) reports (Boye *et al.*, 2010), the combination of fertilization and foliar nutrition provides better photosynthesis rates and raises the soybean productivity under the forest-steppe conditions of Western Ukraine.

For normal growth and development of crops, it is not enough to meet their basic needs for nitrogen, phosphorus, potassium, calcium, magnesium and sulfur. Trace elements are part of many vitamins, enzymes, activate their work, participate in nitrogen and hydrocarbon metabolism of plants, in redox processes, enhance the process of photosynthesis, affect respiration, as well as the transformation and movement of substances, growth, development and stability plants to various adverse factors and pathogens. The main value of trace elements, and they include iron, molybdenum, copper, manganese, zinc and boron - increase the activity of enzymes. Enzymes are biological catalysts that accelerate chemical processes in the body, which increases the overall tone of the plant and has a positive effect on the dynamics of their growth and development. Lack of micronutrients can cause various deviations in the growth and development of plants, which will reduce yields and impair product quality. That is why trace elements cannot be replaced by any other substances, and their lack can negatively affect the growth and development of plants (Yanovych *et al.*, 2018 b; Ahmadi *et al.*, 2010; Honcharuk *et al.*, 2020; Homolka *et al.*, 2012; Hashimi *et al.*, 2019).

Trace elements in plant nutrition allow more complete use of water, light and primary nutrients (nitrogen, phosphorus, potassium), which in turn leads to increased quantitative and qualitative characteristics of the crop. Trace elements and their enzymes promote better tissue repair and significantly reduce the risk of plant disease. Another important factor in the benefits of trace elements is somewhat derived from the previous – they increase the over-

all immunity of the plant, prevent stress or depressive situations, which are the harbingers of disease.

The system of micronutrient feeding of plants should be developed individually for each crop, taking into account the peculiarities of the geographical location and the level of micronutrient removal by the plant.

Materials and Methods

The investigation was carried out during the 2015-2018 period in the field rotation of the State Agrarian and Engineering University in Podilia testing field. The soil is chernozem that is leaching, deep, low-humus, loamy and is on loess-like loams. The testing area has the following agrochemical indicators (0-30 cm⁻¹ soil layer): the content of humus is 4,34%; the content of pH is 6,8%; the content of hydrolysable nitrogen is 124 mg⁻¹ per 1 kg⁻¹ of soil; the content of floating phosphorus is 86 mg per 1 kg of soil; the content of metabolic potassium is 167 mg⁻¹ per 1 kg of soil.

Weather conditions in the years of research (2015-2018) during the growing season of soybean plants were characterized by a certain difference from the average long-term indicators in terms of both temperature and rainfall, but were generally favorable for plant growth and development.

The average daily air temperature in the period May-September exceeded the long-term average in 2015 by 2.2 °C, in 2016 – by 2.1 °C, in 2017 – by 1.9 °C, and in 2018 – by 2.8 °C. As for precipitation, they were characterized by uneven precipitation, but their number was at the level of the long-term average. In total, in 2015, 334.3 mm⁻¹ of precipitation fell during the soybean growing season, in 2016 – 329.3 mm⁻¹, in 2017 – 265.8 mm⁻¹ and in 2018 – 266.8 mm⁻¹.

The investigation also examined how foliar nutrition with trace elements influenced the indicators of soybean photosynthetic productivity. One-element products produced in Germany by Aglukon were used as foliar feed in the standards recommended by the manufacturer:

Boron – Wuxal Folibor, the content of boron is 150 g⁻¹.

Molybdenum – Wuxal Molybdenum, the content of molybdenum is 73 g⁻¹.

Copper – Wuxal Copper, the content of copper is 70 g⁻¹.

Ferrum – Wuxal Ferro, the content of ferrum is 70 g⁻¹.

Manganese – Wuxal Manganese, the content of manganese is 83 g⁻¹.

Zinc – Wuxal Zn, the content of manganese 109 g⁻¹.

The investigation was carried out in the appropriate sowing period, on the 20th of April. Sowing method is wide-row with 30 cm⁻¹ space between rows and has a sowing limit of 550 thousand similar seeds per 1 g⁻¹. ha. The predecessor is soybean. Agricultural equipment used in the investigation is the one that is generally accepted in the forest-steppe zone of Western Ukraine. The research examined the «Suziria» class. The class creator is The National Academy of Agrarian Sciences of Ukraine (Scientific-methodical and coordination center on scientific problems development of the agroindustrial complex of Ukraine). The soybean class of a restricted growth type was recorded in the Plant Variety Register of Ukraine in 2010.

The testing field sown area is 11 m², including 5 m² of the accounting one. The frequency is four times. All foliar feed was added in the soybean initial flowering stage (R1) using a knapsack sprayer.

All research recordings, findings, and analysis were made per the standard methods.

The leaf surface area was determined using the cutting off method. The leaf surface area in the respective phases of plant growth and development was determined by the method of «cuttings». At the experimental site, 10 plants were selected, all leaves were plucked from them and weighed. The content of chlorophyll in the leaves was selected from 20 plants on one leaf (in the fourth tier on top). Pigments content (chlorophyll a, chlorophyll b, and carotene) was defined according to the «Guidelines on the determination of plant photosynthetic activity indicators». Photosynthetic potential, photosynthetic net efficiency and dry matter were rated by A.O. Nychporovych methodology (Nychporovych, 1961).

Results and Discussion

In the process of growth and development of crops a special place is occupied by the dynamics and formation of indicators of photosynthetic productivity of the agrocenosis, as this is the basis of yield of each of the crops. However, it should be noted that the dominant role in the photosynthetic productivity of

the crop is played by the rate and size of the formation of the leaf surface of the crop, as this indicator is associated with all others that ensure the production of yields. Thus, in particular, the rate and size of the assimilation surface of the crop determine the intensity of moisture absorption, nutrients and photosynthetically active radiation from the sun. As a result of such a combination, the crop accumulates dry matter, which is the basis of the vegetative mass and the accumulation of assimilation products, which subsequently provide the quantitative formation of the crop and the full value of its quality indicators (Mazur *et al.*, 2020 b; Kim *et al.*, 2010; Pantsyreva, 2019).

The formation of organic matter due to the photosynthetic activity of plants is determined primarily by the size of the leaf surface. Soybean leaf apparatus is formed in a fairly wide range – from 20 to 70 thousand m² ha, depending on growing conditions. The optimal area of the leaf surface, when a high yield of soybean seeds is formed, is considered to be an area in the range of 40-50 thousand m² ha. According to A. Nichiporovich, the decisive factor here is not the area of the leaves, but the term of its active work. He considers quite productive crops in which the photosynthetic potential is 2 million m² days ha in terms of every 100 days of vegetation that actually took place.

The soybean leaf surface area enlarges from the start of the vegetation period to the end of the flowering stage. To get the analysis of the factors influence, we compared the top assimilation values, which were defined at the time the crop stops flowering. It should be mentioned that during the end of the flowering period, the soybean leaf surface area was 39 thousand m² ha without foliar nutrition with trace elements (Table 1).

Based on the investigation of different crops, it was stated that maximum efficiency was stimulated by the leaf area index of 6 m² (Yanovych *et al.*, 2018 b.; Kaletnik *et al.*, 2020; Puyu *et al.*, 2021). Therefore the soybean leaf surface area enlargement will provide higher crop productivity. The soybean foliar nutrition with particular elements stimulated slight leaf surface area enlargement.

Therefore, increasing the leaf surface area in experimental soybean crops will contribute to higher crop productivity. The use of foliar feeding of soybeans with individual trace elements contributed to a slight increase in leaf area.

It was noticed that the soybean leaf surface area

Table 1. Dynamics of formation of the leaf surface area of Soybean class «Suziria» depending on foliar fertilizer, thousands of m² ha, (average in 2015-2018)

Factor A, Foliar nutrition	Phenological stages					
	Start of the flowering stage		End of the flowering stage		Grain forming	
	x	+/-	x	+/-	x	+/-
Checkout (St)	26.7	-	44.0	-	34.5	-
Boron	26.9	0.3	44.4	0.4	34.5	0.0
Molybdenum	26.5	-0.2	46.1	2.1	34.6	0.2
Copper	27.2	0.5	46.3	2.3	35.8	1.3
Ferrum	27.3	0.6	45.7	1.7	36.0	1.6
Manganese	26.4	-0.3	43.6	-0.4	34.8	0.3
Zinc	26.6	-0.1	43.9	-0.1	34.9	0.4
	x=26.8	LSD ₀₅ =1.1	x=44.7	LSD ₀₅ =1.7	x=35,0	LSD ₀₅ =1.5

increased at the end of the flowering stage in the examples where copper, ferrum, and foliar feed containing molybdenum were added. The leaf surface area with copper added got 46.3 thousand m² ha. It confirms the significance of copper in sugar and protein creation. And copper also contributes to photosynthesis.

In case ferrum was added the leaf surface area also increased, but not much. The value was 1.7 thousand m² ha and meant to be more than the slightest considerable difference at the 95% significance level. This very case showed that the leaf surface area was increasing up to the end of the vegetation period. In that way, in the grain forming period the leaf surface area formed 34,5 thousand m² ha, and in the case, ferrum was added it formed 36,0 m² ha, which was 1.6 thousand m² ha as large (LSD₀₅=1,5 thousand m² ha). It confirms that ferrum plays an important role both in photosynthesis and proteometabolism, and in chlorophyll formation.

It was also noted that adding molybdenum improves soybean foliar nutrition. In this case, the leaf surface area increased to 2.1 thousand m² ha. There is no molybdenum direct impact on the leaf surface enlargement, but it enables the symbiotic nitrogen fixation of nodule bacteria, that, in turn, can improve the photosynthetic activity of the whole soybean plant.

The statistical analysis of investigation findings indicated a considerable impact on the leaf surface area at the end of the flowering and grain forming stages during the three years of observation.

It was determined that there was a curvilinear correlation between the leaf surface area and the yield. And it can be expressed by the following

$$\text{equation } Y = -37,0 + 1,9 * X - 0,02 * X^2.$$

As the leaf surface area goes up to 45 thousand m² ha, the soybean yield rises too. Within the leaf surface area of 45-50 thousand m²/ha, the yield doesn't rise. The regression line extrapolation means that the yield lowers with the next leaf surface area enlargement.

The amount of chlorophyll is a significant internal factor that defines the photosynthesis rate and overall biological efficiency of the plant. The present-day varieties are notable for the higher seed production and more aggressive photosynthetic activity. It is due to high chlorophyll content in leaves and other photosynthetic elements. Mazur V. in her paper mentioned (Mazur et. al, 2019; Mazur et. al, 2020 a) that high-productive barley kinds were characterized by a great amount of chlorophyll in leaves, increased density of pigment set in a photosynthetic membrane, and they also had another type of photosynthetic unit assemblage.

A strong correlation was found between chlorophyll content in leaves, total nitrogen accumulation, and dry matter phytomass in the whole plant. The optimal conditions of soybean watering provided maximum chlorophyll content in the leaves in the flowering stage. During the drought, its content considerably decreased. A lot of authors point out that photosynthesis is in direct relation to chlorophyll content (Bandura et al., 2019; Benbouza et al., 2006; Didur et al., 2021; Kaletnik, 2010). However, it is suggested that this relation is more complex, it means the direct relation can be seen at an early stage of ontogenesis only (Didur et al., 2020; Boye et al., 2010; Honcharuk et al., 2021; Roggatz, 1999; Soltani et al., 2001; Oweis, 2004), notably in the process of chloro-

phyll accumulation. At the time of plant aging, there was a quick photosynthesis intensity decrease, and there was a smaller amount of chlorophyll in the leaves of the soybean flag-shaped leaf. The above-stated information from the scientific documentation confirms that there is a strong correlation between chlorophyll, photosynthesis, and the final output of different crops.

Based on the investigation, it was found out that foliar nutrition generally influences the amount of chlorophyll in the soybean leaves. Within the investigation, the average chlorophyll content in the soybean leaves was $1,10 \text{ mg}^{-1} \text{ g}$ of the raw material (Table 2).

Among the variants examined, added ferrum greatly influenced the chlorophyll content, added copper influenced to a lesser degree, and molybdenum and manganese also increased chlorophyll content.

It is quite important to combine the leaf surface area records with the records of the growth of the biological and economic yield dry matter. In this case, it is possible to get indicators of photosynthetic net productivity.

Table 2. Chlorophyll content in the soybean leaves depending on the foliar nutrition, mg^{-1}g of the raw material, (average in 2015-2018)

Factor A, Foliar nutrition	Phenological stages	
	End of the flowering stage	
	x	+/-
Checkout (St)	0.94	-
Boron	0.92	-0.02
Molybdenum	0.99	+0.05
Copper	1.12	+0.18
Ferrum	1.26	+0.30
Manganese	1.02	+0.08
Zinc	0.95	+0.01
	$x=1.3$	$\text{LSD}_{05}=0.04$

So, during the investigations, the dry matter dynamics was rated per the soybean growth stage. The biggest amount of soybean dry matter was generated during the period of grain forming. $4,97 \text{ t}^{-1}\text{ha}$ of dry matter could be seen.

Foliar nutrition with copper and molybdenum provided the increase of the dry matter amount at the soybean end of the flowering stage. It is due to the more intense activity of the photosynthetic surface, both its optimized area and higher chlorophyll concentration.

The variant of foliar nutrition with boron is notable for the dry matter indicator during the grain forming stage. It is the result of better growth of meristematic cells, better fertilization, and fewer abortions of flowers and beans.

Foliar nutrition with molybdenum also provided the increase of the dry matter amount due to a better activity of symbiotic mechanism and better nitrogen feeding afterwards.

To more fully characterize the functioning of the formed leaf surface area of the studied soybean crops in the southwestern part of the Forest-Steppe of Ukraine, we calculated the photosynthetic potential for the experimental variants, which combined the size of the formed assimilation surface of soybean crops with its duration. Photosynthetic potential is an indicator that reflects the quality of the assimilation surface of the crop, as the longer the period of the leaf surface of the crop, the more assimilation products are formed, which has a direct impact on crop yields.

Thus, the results of research showed that the most effective leaf surface area of crops worked during the flowering of soybeans. In particular, the highest indicators of photosynthetic potential in the experiment were determined on the variants with molybdenum treatment – $1.39 \text{ million m}^{-2} \text{ per day ha}$ (Table 3).

As a result of calculations and observations, it was found that the dynamics of photosynthetic potential in soybeans differs depending on the treatment of crops with trace elements. The increase in photosynthetic potential in the period from the beginning to the end of flowering occurs during the treatment of crops with elements such as molybdenum, copper and iron. This is due to the participation of these elements in photosynthetic processes and their activation. In the period of the end of flowering-grain filling there is already a noticeable positive effect on the photosynthetic potential of all options for crop treatment, which contributed to an increase of $0.03\text{-}0.06 \text{ million m}^{-2} \text{ per day ha}$. Especially significant increase in the variant with treatment of crops with iron. The lowest indicators of photosynthetic potential were observed in the variant with the introduction of zinc $1.28 \text{ million m}^{-2} \text{ per day ha}$, which is $0.04 \text{ million m}^{-2} \text{ per day ha}$ less than the control.

We also calculated the net productivity of photosynthesis of crops. Thus, as a result of the calculations it was found that the largest increase in net

Table 3. Photosynthetic potential of soybean class «Suziria» depending on foliar fertilizer, million m² per day ha, (average in 2015-2018)

Factor A, Foliar nutrition	Period of development	
	Start of the flowering stage – End of the flowering stage	End of the flowering stage – Grain forming
Checkout (St)	1,32	0,95
Boron	1,33	1,01
Molybdenum	1,39	0,98
Copper	1,37	0,99
Ferrum	1,37	1,10
Manganese	1,31	1,00
Zinc	1,28	0,98

Table 4. Net productivity of photosynthesis of soybean class «Suziria» depending on foliar fertilizer, g m² per day (average in 2015-2018)

Factor A, Foliar nutrition	Period of development	
	Start of the flowering stage – End of the flowering stage	End of the flowering stage – Grain forming
Checkout (St)	2,06	0,62
Boron	2,60	0,75
Molybdenum	2,19	0,82
Copper	2,02	0,91
Ferrum	2,05	0,87
Manganese	2,11	1,04
Zinc	2,15	0,95

productivity of photosynthesis in the experiment was in the period of “start – end of the flowering” of soybeans. Namely: during this period, the experimental crops produced from 2.02 to 2.60 g m² per day of dry matter (Table 4).

The effect of foliar fertilization with boron and molybdenum on this integrating indicator was insignificant, but significant in the period between the beginning and end of flowering. For the period from flowering to grain filling, treatment with all nutrients had a significant positive effect on improving the net productivity of soybean crops.

Conclusion

Soybean foliar nutrition with trace elements influences its photosynthetic productivity indicators. The leaf surface area increases if copper, Ferrum, molybdenum, and manganese added. Adding all the elements except zinc increases dry matter accumulation and soybean photosynthetic potential. The effect of foliar fertilizer on the photosynthetic potential of soybean crops and the net productivity of photosynthesis of crops was insignificant, but sig-

nificant.

References

- Ahmadi, H., Akbarpour, V. and Shojajaeian, A. 2010. Effect of different levels of nitrogen fertilizer on yield, nitrate, accumulation and several quantitative attributes of five Iranian spinach accessions. *American-Eurasian Journal of Agricultural and Environmental Science*. 8(4) : 468–473.
- Bandura, V., Mazur, V., Yaroshenko, L. and Rubanenko, O. 2019. Research on sunflower seeds drying process in a monolayer tray vibration dryer based on infrared radiation. *INMATEN. Agricultural Engineering*. 57(1) : 233–242
- Benbouza, H., Jacquemin, J.M., Baudoin, J.P. and Mergeai, G. 2006. Optimization of a reliable, fast, cheap and sensitive silver staining method to detect SSR markers in polyacrylamide gels. *Biotechnol. Agron. Soc. Environ.* 10 : 77–81.
- Boye, J., Zare, F. and Pletch, A. 2010. Pulse Proteins: Processing, Characterization, Functional Properties and Applications in Food and Feed. *Food Research International*. 43(2): 414–431.
- Didur, I., Bakhmat, M., N̄hynchuk, O., Pansyryeva, H., Telekalo, N. and Tkachuk, O. 2020. Substantiation

- of agroecological factors on soybean agrophytocenoses by analysis of variance of the Right-Bank Forest Steppe in Ukraine. *Ukrainian Journal of Ecology*. 10(5) : 54–61.
- Didur, I., Nhnchyk, O., Pansyryeva, H., Olifirovych, S., Olifirovych, V. and Tkachuk, O. 2021. Effect of fertilizers for *Phaseolus vulgaris* L. productivity in Western Forest-Steppe of Ukraine. *Ukrainian Journal of Ecology*. 11(1) : 419–424.
- Hashimi, R., Afghani, A.K. and Karimi, M.R. 2019. Effect of organic and inorganic fertilizers levels on spinach (*Spinacia oleracea* L.) production and soil properties in Khost Province, Afghanistan. *International Journal of Applied Research*. 5(7) : 83–87
- Honcharuk, I. and Pansyryeva, H. 2020. Efficiency of growing legumes crops in Ukraine. In : *Integration of traditional and innovation processes of development of modern science: ñollective monograph* (3rd ed). (Ed. A. Jankovska). Baltija Publishing, Riga, Latvia, pp. 42–65. DOI: 10.30525/978-9934-26-021- 6-31.
- Honcharuk, I., Kupchuk, I., Solona, O., Tokarchuk, O. and Telekalo, N. 2021. Experimental research of oscillation parameters of vibrating-rotor crusher. *Przegld Elektrotechniczny*. 3: 97–100. DOI: 10.15199/48.2021.03.19
- Homolka, P., Koukolova, V., Podsednicek, M. and Hlavackova, A. 2012. Nutritive value of red clover and lucerne forages for ruminants estimated by *in vitro* and *in vivo* digestibility methods. *Czech J. Anim. Sci.* 57(10) : 454–568.
- Kaletnik, G.M. 2010. *Biofuels. Food, Energy and Environmental Security of Ukraine: Monograph*. K: High-tech Press, 516 p.
- Kaletnik, G., Honcharuk, I. and Okhota, Y. 2020. The Waste-Free Production Development for the Energy Autonomy Formation of Ukrainian Agricultural Enterprises. *Journal of Environmental Management and Tourismthis*. 11(3): 513–522.
- Kim, P., Leckman, J.F., Mayes, L.C., Feldman, R., Wang, X. and Swain, J.E. 2010. The plasticity of human maternal brain: Longitudinal changes in brain anatomy during the early postpartum period. *Behavioral Neuroscience*. 124 : 695–700.
- Mazur, V.A., Pansyryeva, H.V., Mazur, K.V. and Didur, I.M. 2019. Influence of the assimilation apparatus and productivity of white lupine plants. *Agronomy Research*. 17. Ð. 206–219.
- Mazur, V., Pansyryeva, H., Mazur, K., Myalkovsky, R. and Alekseev, O. 2020. Agroecological prospects of using corn hybrids for biogas production. *Agronomy Research*. 18 : 205–219.
- Mazur, V.A., Myalkovsky, R.O., Pansyryeva, H.V., Didur I.M., Mazur, K.V. and Alekseev, O.O. 2020. Photosynthetic productivity of potato plants depending on the location of rows placement in agrophytocenosis. *Ecology, Environment and Conservation*. 26(2) : 46–55.
- Mazur, V.A., Pansyryeva, H.V., Mazur, K.V., Myalkovsky, R.O. and Alekseev, O.O. 2020. Agroecological prospects of using corn hybrids for biogas production. *Agronomy Research*. 18(1): 177–182. DOI: 10.15159/ar.19.024
- Nychyporovych A.A. 1961. Fotosyntetycheskaia deiatelnost rastenyi v posevakh: (Metody y zadachy ucheta v sviazy s formyrovanyem urozhaev). P. 133 s.
- Pansyryeva, H.V. 2019. Morphological and ecological-biological evaluation of the decorative species of the genus *Lupinus* L. *Ukrainian Journal of Ecology*. 9(3): 74–77.
- Puyu, V., Bakhmat, M., Pansyryeva, H., Khmelianchyshyn, Y., Stepanchenko, V. and Bakhmat, O. 2021. Social-and-Ecological Aspects of Forage Production Reform in Ukraine in the Early 21st Century. *European Journal of Sustainable Development*. 10(1) : 221–228.
- Roggatz, U., McDonald, A.J.S., Stadenberg, I. and Schurr, U. 1999. Effects of nitrogen deprivation on cell division and expansion in leaves of *Ricinus communis* L. *Plant, Cell and Environment*. 22(1) : 81–89. DOI:1046/j.1365-3040.1999.00383.x
- Soltani, A., Khoorie, F.R., Ghassemi-Golezani, K. and Moghaddam, M. 2001. A simulation study of chickpea crop response to limited irrigation in semi-arid environment. *Agricultural Water Management*. 95: 171–181.
- Oweis, T., Hachum, A. and Pala, M. 2004. Water use efficiency of winter-sown chickpea under supplemental irrigation in a Mediterranean environment. *Agricultural Water Management*. 66 : 163–179.
- Vdovenko, S.A., Pansyryeva, G.V., Palamarñhuk, I.I. and Lytvyniuk, H.V. 2018. Symbiotic potential of snap beans (*Phaseolus vulgaris* L.) depending on biological products in agrocoenosis of the right-bank forest-steppe of Ukraine. *Ukrainian J Ecol*. 8(3) : 270–274.
- Yanovych, V., Honcharuk, T., Honcharuk, I. and Kovalova, K. 2018 a. Engineering management of vibrating machines for targeted mechanical activation of premix components. *INMATEH. Agricultural Engineering*. 54 (1) : 25–32.
- Yanovych, V., Honcharuk, T., Honcharuk, I. and Kovalova, K. 2018b. Engineering management of vibrating machines for targeted mechanical activation of premix components. *INMATEH. Agricultural Engineering*. 54(1) : 25–32.