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THE IMPACT OF A PRECISION MONITORING SYSTEM ON VEGETABLE CULTIVATION IN RURAL AREAS

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ABSTRACT

The modern development of recent years has not left agriculture untouched either. The advent and introduction of precision technology have accelerated events further. Slowly, even the smallest farms are trying to move from the methods they have become accustomed to as much as possible, using precision technology to make their operations more efficient and profitable, as those who lag behind will lag behind and will not be sufficiently competitive with other producers. Precision development covers all areas, we have the opportunity to apply new knowledge and technologies in sowing, irrigation, plant protection, harvesting, and last but not least, nutrient replenishment and even other areas. This development is a major task and very topical for smaller producers in rural areas, as they need to develop and create the necessary financial resources, which in many cases can only be achieved in the form of subsidies from different locations. This is all the more true for horticultural crops, since, for example, in contrast to the arable crop production, producers have much higher energy and capital requirements to achieve the same level of profit. In the course of the study, we examined the opinion of the producers supported by the Southern Horticultural Cooperatives – Délalföldi Kertészek Szövetkezete (DélKerTÉSZ) - whether the Agro Sense decision support precision tool placed to them had improved their production conditions and made their production more profitable due to the use of the tool.

Keywords: precision agriculture, vegetable growing, rural development, rural area

INTRODUCTION

GÁL ET AL. (2013) state that the goal of precision farming is to produce the best possible quality and safe food so that resources are utilized in the most efficient way possible, yet sufficient raw material remains for our offsprings as well. At first glance, this may not differ any way from the principles of traditional farming, but the main difference is that the efficiency of information acquisition using digital technologies gives producers a much greater development perspective and increases their competitiveness, resulting in better results compared to the traditional production, while placing a strong emphasis on sustainability. Precision farming, as the word implies, helps make farming more accurate and disciplined. It helps the farmer to plan production meticulously, takes the burden of making a decision off their shoulders, for example with the help of analyzed data collected by various monitoring / decision support tools. All this even so that the producer may have the opportunity to set up the optimal values per square meter or per crop, instead of a uniform stock management.

The above described things sound good, but in many countries, including Hungary, there is a great deal of financial differences between the regions, due to which the developments are not proportionate to each other. At the domestic level, small and medium-sized farms do not have enough technical knowledge and financial background to introduce modern technologies, so there is a need for easy-to-use and cheaper equipments, otherwise the difference in production levels between small and large farms will increase (JÓRI, 2019).

Typically, younger, higher-educated, and capital-intensive producers are those who are more open to new technologies, but most producers belong to the middle and older age groups (BERNARDI AND INAMASU, 2014; FOUNTAS ET AL., 2005; ANTOLINI ET AL. (2015); DEFRA (2013). In addition to the financial conditions, there is a need to ensure professional knowledge so that producers can process the data efficiently. According to HADÁSZI (2018), only 20 percent of the highly valuable data from precision instruments are used. In June 2016, the European Parliament decided that barriers to the spread of precision agriculture should be removed and producers should be encouraged to adopt new technologies (HUSTI, 2018). Farmers' cooperatives, and special bank loans and a part or all of the reimbursable subsidies also have an incentive effect on certain producers, as well as high-quality advisory services to help them learn how to use valuable data in production (NAK, 2019). Lots of modern technological elements have already emerged in all areas of agriculture, both in animal husbandry and crop production. In animal husbandry, it can be said that there is no significant difference in the development of certain sectors, but this is no longer true for crop production. The repertoire of precision tools that can be used in the cultivation of field crops is much wider and more mechanizable than in fruit production or by horticultural crops, where in many cases it is difficult or impossible to replace live labor with machines. In the latter two sectors, perhaps the greatest assistance of precision tools to the producer are currently in forecasting and monitoring systems. Areas that can be automated (e.g. irrigation, nutrient replenishment, ventilation, etc.) do not require a special human presence. There are many types of monitoring systems on the market today, such as: Autogrow / IntelliDose; IntelliClimate; MultiGrow / [1], Sensaphone [2] [3] [4] [5], RESORT AGRO - MONITOR [6] [7] [8], BDPA Automation Kft. [9] and Agro Sense [10].

Agro Sense decision support monitoring system:

The Agro Sense distributed by Sys-Control Ltd. stands out from the precision monitoring systems prevalent in the domestic market, which is in partnership with companies such as KITE Ltd., Syngenta and DélkerTÉSZ in Szentes. During the past 7 years, this precision instrument has been installed in 6 countries and in more than 70 locations. Its field of application is very wide: in orchards, greenhouses, arable lands and in field vegetable production. The system itself consists of wireless mini meteorological stations, Agro Sense Bases, which measure precipitation, wind direction, wind speed, air temperature, air humidity, air pressure, incident solar radiation, photosynthetically active solar radiation, and ground temperature. They consist of different sensors, Agro Sense Nodes, which measure soil or agent moisture, conductivity (EC), leaf moisture, air temperature, humidity, but it is important that the sensors have to be placed right next to the plants. It is quick and easy to install and manage, and provides users with accurate and precise data on which they can base their cultivation decisions. It collects and stores data, allowing users to access them anytime and anywhere if they have an internet connection. To achieve a better effect, distributors recommend growers the Agro Sense Trap, a pheromone insect trap that takes a picture of the insects caught and counts the pests caught daily and transmits the collected data to the Base unit. When the parameters measured in the system, reach the set limits, it sends a notification to the producer in the form of a message. [10]

MATERIALS AND METHODS

The main aim of the survey was to examine the impact of the Agro Sense decision support system on producers and their decisions, how they see what positive and negative experiences they have using the system. We also asked the users about what expansion opportunities they think Agro Sense has and whether they want to develop their own tools further. We tried to assess this with the help of a detailed questionnaire and we made personal interviews with the producers. In 2016, DélKerTÉSZ deployed the Agro Sense measuring network at its Szentes-Szentlászló foil plantation for the first time at its three producers for experimental purposes. At that time, they had one base station and three substations and the corresponding measuring sensors. Farmers usually produce white conical peppers on rockwool or on coconut fiber substrate in soilless culture, in plastic tunnels heated with thermal water, or in some cases unheated, with several years of experience. Later, another 10 producers joined the experiment, so currently the system has been installed at 13 producers in the last 5 years. The precision device is based on providing almost realtime information about growing conditions with the help of sensors: substrate temperature, water capacity, EC, air humidity, air temperature. In addition, the meteorological data of the base station are immediately received by the producers: outdoor temperature, humidity, irradiation, air movement data and precipitation. Each grower can track the data generated by the system with an individual code, edit it for a specified period, display it graphically, and compare the individual factors. The consultants of DélKerTÉSZ also have access to all data sets.

The survey was conducted by using an online, anonymous questionnaire consisting of 24 questions in early February, 2021. The questionnaire was sent to all 13 producers, 10 of whom contributed to the completion and provision of data. The composition of the questions was varied. The first part was used to gather general, more personal information (gender, age). In addition, the respondents answered questions about their way of production and how long they had been using Agro Sense. There were questions to which their answers could be determined on a scale of 1 to 5. The questions focused on how much the producers are satisfied with the system, whether they find it reliable, and whether they think it is easy to manage, if it can positively influence their production decisions. Most of the other questions were multiple-choice, where they could choose the ones that corresponded to them from the given values and answers.

RESULTS

The soilless technology is becoming more and more widespread in the Hungarian indoor vegetable production. The producers in TÉSZ mainly use rockwool and coconut fiber substrate. The greenhouses are covered with a double-layer plastic film, vegetables are grown under partly regulated climatic conditions. The greenhouses are heated by thermal water. The technical equipment of greenhouses would need to be improved, since most of them have been in production more than 15 years, so their replacement would be justified. Soilless cultivation is characterized by a more efficient water and nutrient utilization, which also means an improvement in cost-effectiveness.[11] The producers asked in this study have limited possibilities to install for example, certain control units (climate control) in their greenhouse. The evaluation is based on a comparison of the responses provided by the 10 producers. During the comparisons, we tried to get the opinion of the majority, but the evaluation was also done on an individual basis. During the evaluation, it

is worth considering the useful information, criticisms and suggestions obtained from the producers' responses, in order to improve the quality of the service, to raise its standard, and to introduce new developments. A similar survey has already been carried out among producers in 2018, the results of which are as follows:

“There was a consensus among the producers involved in the testing that the use of sensors was beneficial. It keeps track of temperature changes in the plastic tunnel, and soil moisture data informs and helps with irrigation planning. The values of EC and substrate humidity, and their daily and weekly changing tendency provide good feedback in the evaluation of nutrient solution. The web interface is very good, you can keep track of the values, you can look back at the data of certain periods, it also allows for later analyzes. Cultivation becomes safer, the amount of nutrients and irrigation water applied can be adjusted more confidently. The possibility of continuous monitoring of water capacity during the summer was particularly a big step forward. Irrigation shortage caused by a possible technical fault can be controlled almost immediately.”[12]

The growers' opinions have not changed over the years, so most of them find the AgroSense useful and enjoy using it. Over the years, they have drawn even more experience and ideas from the possibilities offered by the system. Now, during the survey, we had the opportunity to ask what is good and what should be changed by the system developers. Parameters monitored regularly has not changed by now. The temperature of the substrate and the soil, the humidity of the air and the water capacity are in the first place. What was surprising, however, is that parameter EC was monitored rarely, which was still regularly monitored during the post-deployment survey. This may be related to the insufficient and fast maintenance work, which means that they cannot make decisions based on these values, but have to rely on their own experience in production. So, the position of the growers is that there would be a great need to speed up the maintenance and repair processes, make them smoother and maintain the software on a regular basis. In the first survey, they found it useful to have access to their data on the web interface, which has not changed since then, as where there is an internet connection, they can access their own user interface and retrieve the data by any means. One of the biggest benefits is the fast information service, which gives the producer great security about their daily tasks. This significantly shortens the “reaction time” and can quickly correct any problems that may arise. As the system stores the data collected in the given periods, it can serve as a useful basis for planning and optimizing the production processes in the next growing season. It can provide not only estimation but also figures, so with the help of simpler or even more complex calculations it is possible to reduce and plan expenses. This was also confirmed during the survey, although not all producers made calculations, but they were unanimous in their opinion that the system reduced their costs and the amount of raw materials used. So, summing up the above, the lives of producers have become easier and more predictable in the recent period. The DélKerTÉSZ helped the producers participating in the experiment both professionally and financially, as they did not have to invest in the system from their own resources, but the system was outsourced to them with the support of the TÉSZ.

DISCUSSION

In many cases, the system has proven to be useful in making production decisions. The farmers' lives have been greatly facilitated and a part of their daily tasks has been taken over by AgroSense, which collects them data every hour of the day, saves time, energy and money for them as they can make their decisions based on these data. The shortcomings of

AgroSense also became clear during the survey. To the producers' opinion they would only extend the monitoring tool, if the maintenance process were carry out quickly and smoothly.

In several cases, it took months to replace a defective part. Also, there would be a need for periodic recalibrations, which would give even more certainty to producers in their decision-making. The other direction of development suggested by farmers is not only to have remote monitoring of the system, but also to provide opportunity to perform the necessary interventions. In soilless pepper production beside fractional climate control development of pepper plants under plastic greenhouses might be regulate by nutriant and water dosage based on the producers' experiences. Using sensor based DS tools growers, for instance, could judge whether the variation of daily water capacity in the substrate or soil would have been sufficient for reliable plant development. However, in modern greenhouses irrigation is controlled by automated climate computers based on solar radiation, while small growers could not afford to buy these automated tools. Consequently, small farmers producing in low-tech greenhouses can establish their technology implementing DS tools (like AgroSense) and decrease the risk of their growing. Investment of these sensorbased tools is more affordable to the automated climate control computers in high-tech greenhouses.

Our proposal for AgroSense operators would be to place more emphasis on the farmers' opinion in the future and to monitor their feedback. The survey also made it clear that at the moment the main problem has ocured with the sensors accuracy and the maintenance processes. This makes everyday life difficult for producers and they cannot facilitate their decisions with the help of the system. We believe that if these problems were solved, producers would be even more satisfied and more likely to expand more devices into their greenhouses or even they would recommend the AgroSense tools to their fellow producers. On the other hand, DélKerTÉSZ would also have a better chance of expanding and continuing its cooperation with AgroSense if it could really deliver the best quality service to its producers. According to the survey, there would be a need for expansions on the part of producers, so I recommend DélKerTÉSZ to pay more attention to the monitoring system and encourage the system operator to perform-regular maintenance work. So, in that way DélKerTÉSZ can promote and support the interests of producers with even greater security than they have done so far. An exemplary support system could be developed that could be adapted to other parts of the country to start catching up and reduce extremism among producers and allow everyone to produce on an equal footing with a similar level of technology.

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THE EFFECT OF DIFFERENT SUBSTRATES ON MORPHOLOGICAL CHARACTERISTICS OF ACCLIMATIZED *BOWIEA VOLUBILIS***MÁTÉ ÖRDÖGH¹, DÓRA FARKAS^{2*}**

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ABSTRACT

Before acclimatization of *Bowiea volubilis*, *in vitro* propagated bulbs were cleaned and separated into four sizes (from 6 to 15 mm). We formed a total of 10 groups with 30-30 individuals, distributing the sizes evenly. Four types of substrate (peat, perlite, coconut fiber, sand) and their mixtures of 50-50% were used. Previously we examined three parameters: length, diameter and weight of the bulbs; later the weight of the successfully acclimatized plants, the number and length of roots and leaves were measured. The acclimatization was done in one of the greenhouses of the Buda Arboretum, where the plants were grown with fleece covering till one month, irrigated every three days, without the use of nutrient replenishment and artificial lighting. After 3 month period, survived plants developed effectively on peat + perlite, sand + perlite and sand + peat mixtures. In these cases, we achieved the largest increases in roots, green parts, bulbs and total weight.

Keywords: *Bowiea*, acclimatization, substrates, morphological features

INTRODUCTION

Bowiea volubilis is an endemic (South African), drought tolerant, traditional medicinal plant with large, poisonous, round shaped bulb, twisted, long (sometimes 3 m) green stems and inconspicuous, yellowish-green flowers (WATT AND BREYER-BRANDWIJK, 1962). The over-collecting of bulbs (which contains cardiac glycosides – CUNNINGHAM, 1988) drastically decreased wild populations, especially when tons of bulbs were sold every years (HANNWEG ET AL., 1996). Because of the small seed production, low germination ratio (DYER, 1964) and difficult division of succulent, fleshy bulbs (with slow regrowth), certain *in vitro* studies were carried out in order to multiply the plants effectively (HAVRANEK AND NOVAK, 1976). Sterilised segments of bulbs (JHA AND SHEN, 1985; COOK ET AL., 1988) or inflorescence stalks (HANNWEG ET AL., 1996) were placed onto MURASHIGE AND SKOOG (1962) media with different hormones (2,4-D, BA, NAA) and thereafter, during multiplication, rooting, acclimatization of shoots, hormone-free media, clean substrates (for example sand + peat) were resulted high volumes of plantlets, even 1000 specimens from 1 explant. In this work, the aim was to find morphological differences between the survived plants and ascertain the effects of different substrates on the success of acclimatization.

MATERIALS AND METHODS

3.1. Plant material, substrates, culture conditions

Before acclimatization, *in vitro* bulbs were cleaned (their roots, shoots removed, *Figure 1*), and classified into 4 sizes (6-8; 9-10; 11-12; 13-15 mm, *Figure 2*) in order to provide homogenous stocks in every groups. We formed 10 groups with 30-30 individuals, distributing the sizes evenly. Four types of substrate (peat, perlite, coir, sand) and six kinds of fifty-fifty percent combinations were used (*Figure 3*). We acclimatize the stocks in one of the greenhouses of the Buda Arboretum, where the plants grown with veil foil (fleece) covering until one month and during the whole period (3 month), irrigated every three days, without nutrient replenishment and artificial lighting.

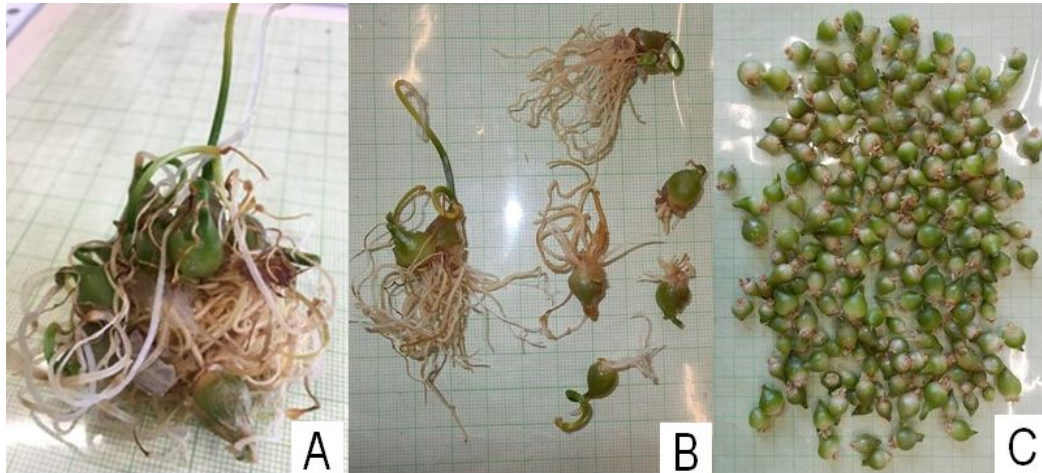


Figure 1: *Bowiea volubilis* *in vitro* bulbs in clusters before division (A), before (B) and after (C) cleaning



Figure 2: Classified *in vitro* bulbs (ready to acclimatization)

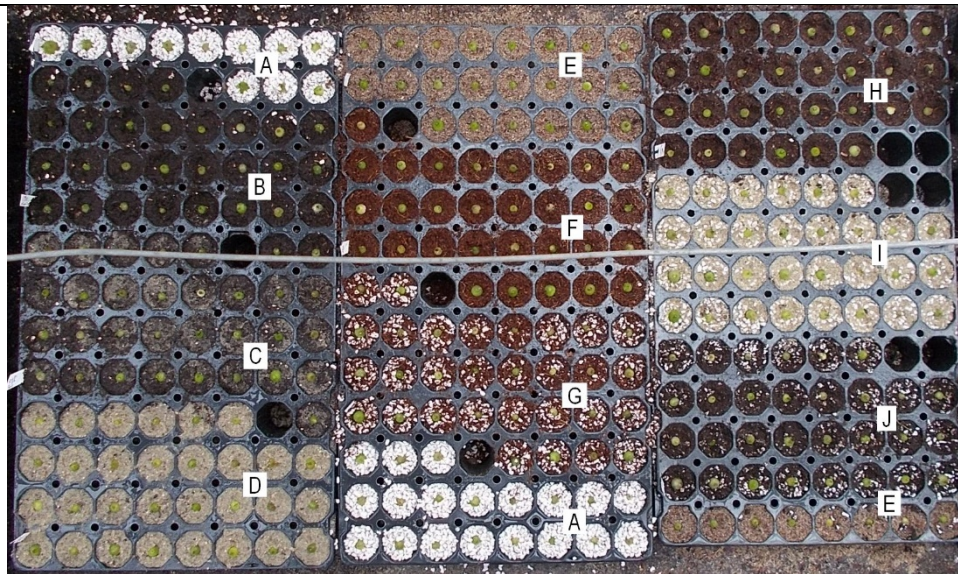


Figure 3: Start of acclimatization - newly planted bulbs in different substrates (A: perlite, B: peat, C: sand + peat, D: sand, E: sand + coir, F: coir, G: coir + perlite, H: peat + coir, I: sand + perlite, J: peat + perlite)

Previously we examined three parameters: length, diameter and weight of the bulbs; 3 months later the same bulb values and total weight of the successfully acclimatized plants, the number and length of roots, leaves were measured.

Data and statistical analysis

Data were evaluated by SPSS. An analysis of variance (ANOVA) was conducted to calculate the statistical significance of all data presented. When significant differences between treatments were found, the means were separated by Tukey's test at $p < 0.05$.

RESULTS

Fresh total plant and bulb weight

Averagely, the heaviest (2.05 g) plants (as measuring total plant weight) were found on peat + perlite and pure sand or perlite resulted significantly easier (0.75-0.78 g) specimens. If we combined sand with peat or perlite, plants with relatively good weight (1.67 and 1.74 g) were obtained. Investigation of bulb weight (certainly after defoliation and remove roots), we got similar tendency. Thus, plants developed the heaviest bulbs on peat + perlite (0.65 g), sand + perlite (0.64 g) and sand + peat (0.53 g), and the easiest bulbs on 100% sand or perlite (0.35 and 0.36 g, *Figure 4*).

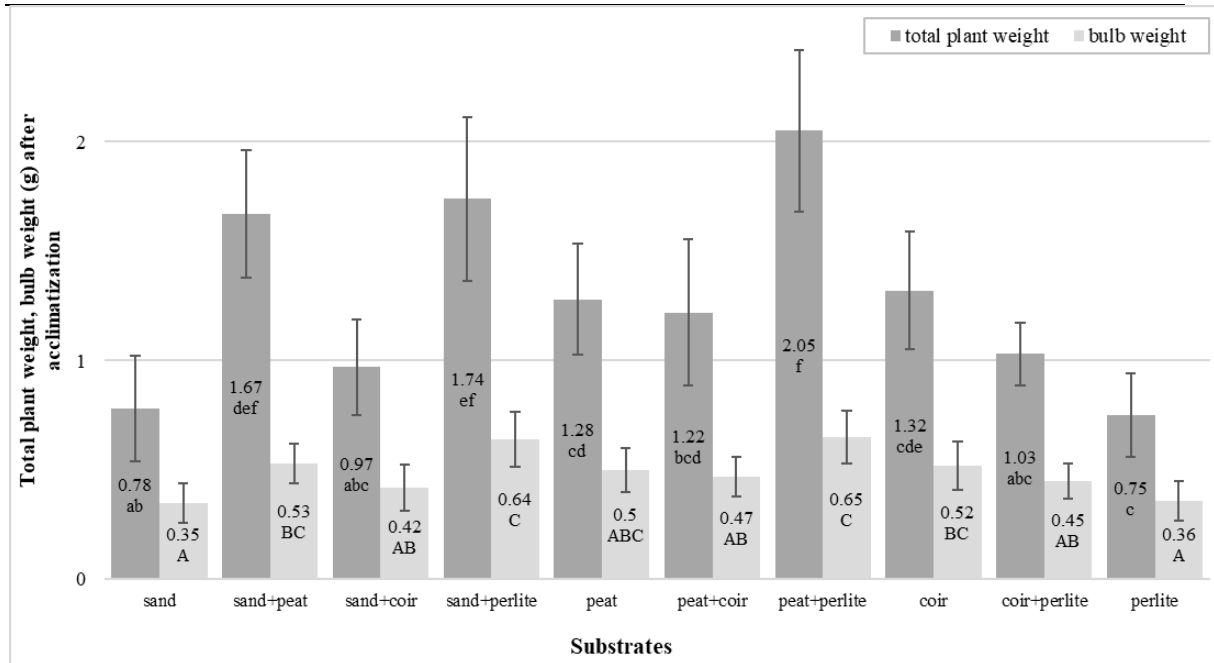


Figure 4: Total plant weight, bulb weight of *Bowiea volubilis* acclimatized plants. Means with different letter are significantly different by Tukey's test at $p < 0.05$

Fresh bulb height and diameter

We noticed that during the acclimatization period, sizes (height and diameter) of bulbs decreased on average despite of their larger weight, probably due to water storing and tissue transformation. It was observed mainly in 100% peat with the lowest sizes (7.7 mm and 8.47 mm), although its bulbs mass values can be said to be average. On the other hand, sand + perlite and sand + peat resulted the largest height (10.9 mm) and diameter (10.27 mm) values after acclimatization (Figure 5).

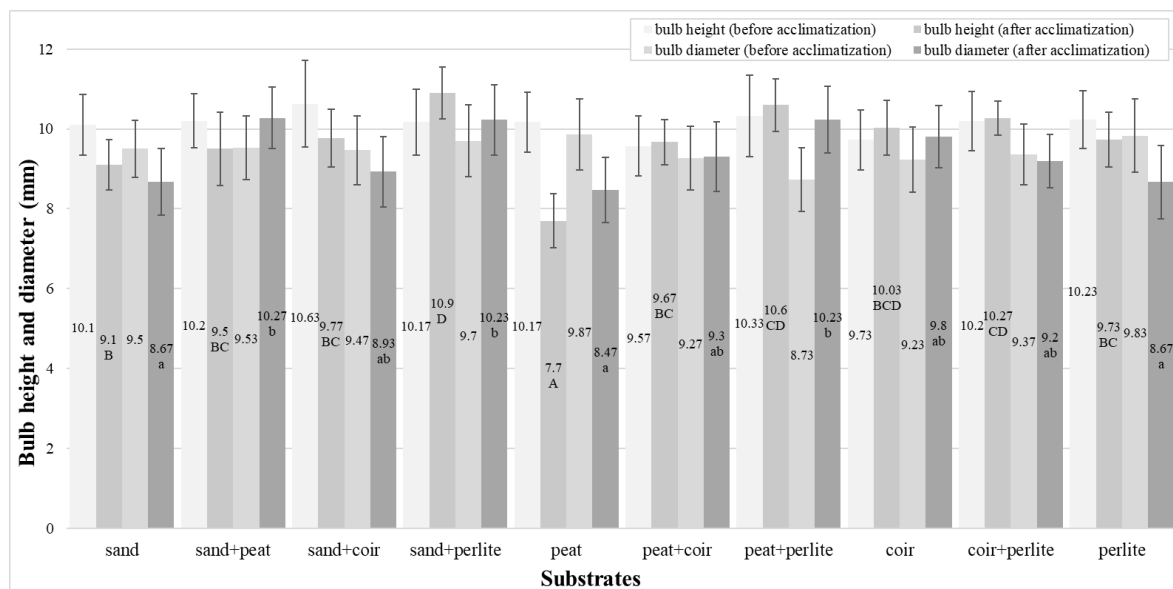


Figure 5: Bulb height and diameter of *Bowiea volubilis* acclimatized plants. Means with different letter are significantly different by Tukey's test at $p < 0.05$

Root number and length

According to the root number, all groups produced almost the same values (5-6) without considerable differences. By contrast (in case of root length), we found significantly longest (69 mm) roots on perlite combined with peat or sand and the shortest on pure sand (38 mm). We have good results (with roots longer than 60 mm) in the presence of 100% coir, 50-50% coir + perlite (Figure 6).

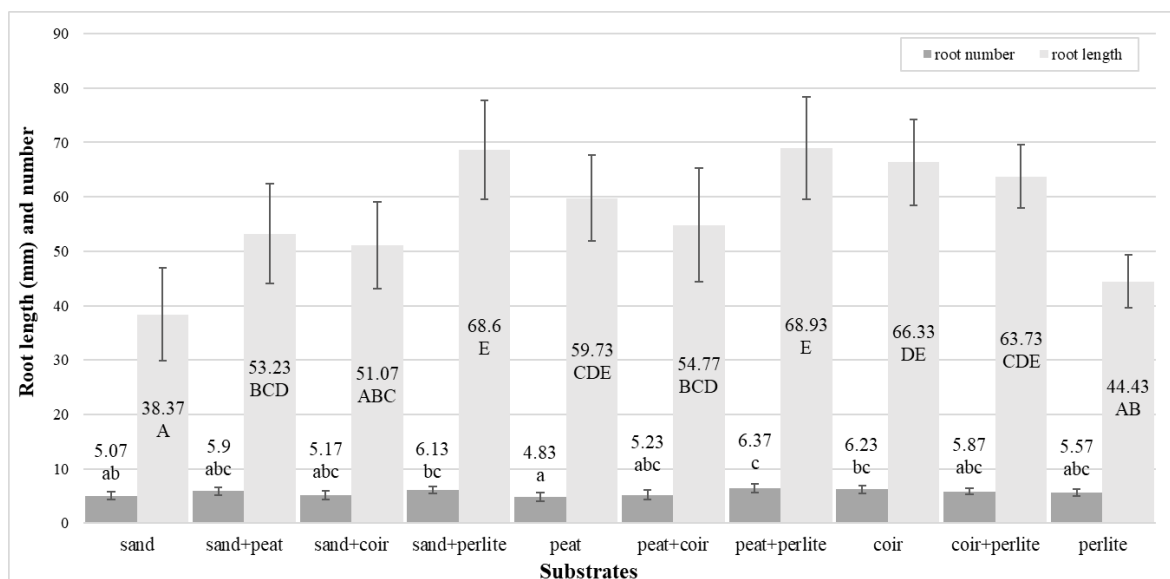


Figure 6: Root number and length of *Bowiea volubilis* acclimatized plants. Means with different letter are significantly different by Tukey's test at $p < 0.05$

Leaf number and length

Normally, young *Bowiea volubilis* specimens can produce only one or two (rarely three) simple, straight leaves without generative organs. For this reason, we found almost the same leaf number in all group without great differences. In case of leaf length, peat + perlite resulted the longest (272 mm) leaves, and the shortest ones (128 mm) on 100% sand. Compare with nearly all the other group, the latter substrate has negative effect with significant differences (Figure 7).

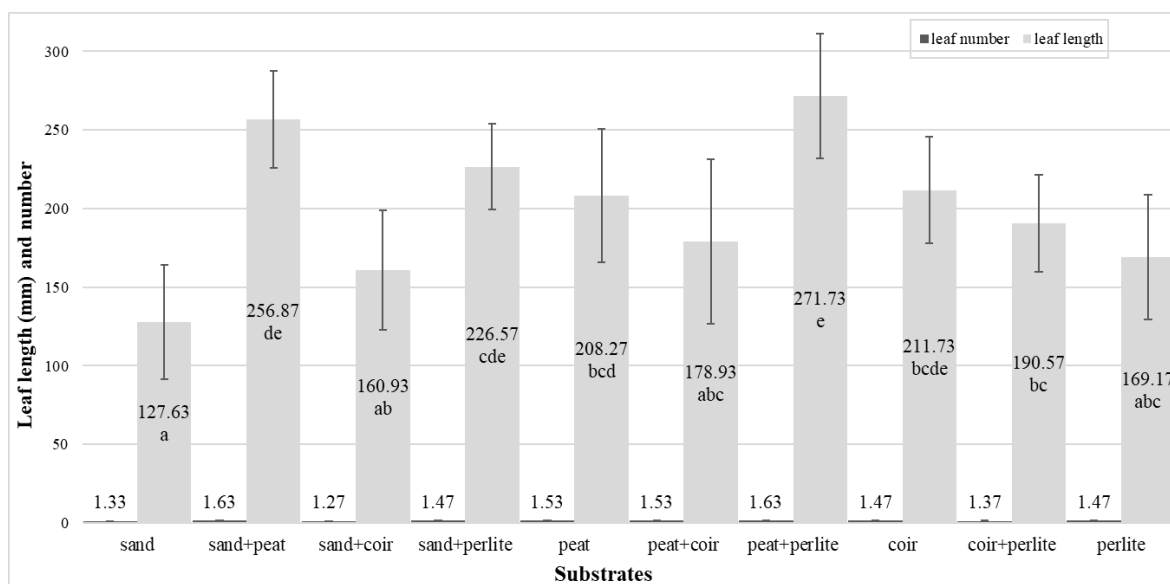


Figure 7: Leaf number and length of *Bowiea volubilis* acclimatized plants. Means with different letter are significantly different by Tukey's test at $p < 0.05$

Larger, older bulbs develop longer, twisted adult shoots with small, inconspicuous, greenish-yellow flowers. In our trial, only few individuals (*Figure 8: A*) produced this kind of shoots (because of small, young bulbs with mainly juvenile leaves, *Figure 8: B*), but as it turned out, bulbs with originally larger weight have better chance to develop curly, flowering stalks and achieve larger plant weight. However, production of adult typed shoots required higher energy from the bulbs; so, lower bulb weight gain was typical in these cases (*Figure 9*).



Figure 8: Acclimatized *Bowiea volubilis* plants with adult shoot (A), juvenile leaves (B)

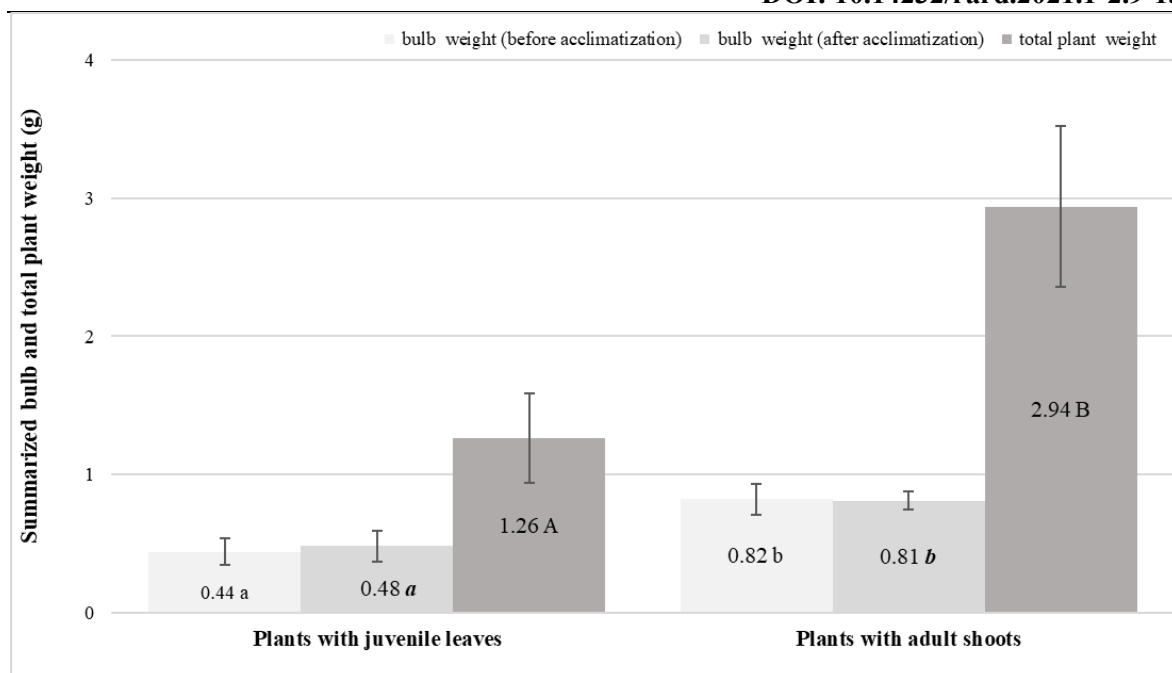


Figure 9: Summarized *Bowiea volubilis* bulb weight (before and after acclimatization), total plant weight of plants with juvenile leaves and adult typed shoots

DISCUSSION

All in all, our results showed that the plants developed efficiently on peat + perlite, sand + perlite and sand + peat mixtures. In these cases, we achieved the greatest increase in bulbs and total weight, as well as the most intense shoot and root formation. Plants grew the least in the case of 100% sand or perlite, but interestingly, the mixture of these substrates yielded significantly better weight values than using only pure sand or perlite. Furthermore, a larger bulbs weight have a better chance to develop curly, flowering adult stalks.

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THE IMPACT OF VARIOUS PRIMARY TILLAGE METHODS ON THE YIELD COMPONENTS OF DRY BEAN**TAMÁS MONOSTORI^{1*}, GERGELY TÓTH², ÁDÁM BORDÉ¹, PÉTER JAKAB¹, VINCE LÁNG²**¹University of Szeged Faculty of Agriculture, Andrásy Street 15, 6800
Hódmezővásárhely, Hungary²Discovery Center Nonprofit Ltd., Hársfa Street 1, 2100 Gödöllő, Hungary*Corresponding author: tamas.monostori@mgk.u-szeged.hu**ABSTRACT**

In Hungary, dry bean (*Phaseolus vulgaris* L.) has been being popular as food and even as kitchen garden crop for centuries but currently only 20% of the annual domestic consumption is produced by the Hungarian agriculture, with the missing 80% coming from import. Improvement of production technology adapted to the new varieties of higher yield potential can contribute to the increase in domestic production. In our experiment, no significant differences could be found between the yield component and yield data of inversion (2.66 tons ha⁻¹) and non-inversion (2.62 tons ha⁻¹) tillage methods. Strip-tillage, however, resulted in higher values for almost all parameters compared to the other two methods. In the case of yield per plant, the difference was significant (24.35 vs. 18.33-18.57 grams ha⁻¹). As the plant density was significantly lower for strip-tillage, despite the significantly higher yield per plant, the yield per hectare results became the lowest (1.39 tons ha⁻¹) here. From the conditions detected after emergence, it was obvious that the harmonization of strip-tillage and sowing was not perfect. As the higher yield component and yield per plant data can be explained both by the lower plant density and the superiority of strip-tillage, the repetition of the experiment is essential.

Keywords: dry bean, strip-tillage, inversion tillage, non-inversion tillage, yield**INTRODUCTION**

Dry bean (*Phaseolus vulgaris* L.) is an important food crop, usually being among the first 10 according to the size of its growth area in the world (33 million hectares in 2019; FAO, 2021). Although being popular as food and even as kitchen garden crop for centuries, its growth area has never been large in Hungary, in the last five years being between 1,415 and 1,713 hectares with a yield between 1.81 and 2.23 tons per hectare (KSH, 2021). Since the 1960's with even more than 30,000 hectares in some years, the growth area continuously decreased stepping below 1,000 hectares in 2006 (FAO, 2021). Currently, only 20% of the annual domestic consumption of dry beans is produced by the Hungarian agriculture, with the missing 80% coming from imports, mainly from China, Ethiopia and Slovakia. The primary aim of our EIP-AGRI project was to change this ratio in favour of domestic production. The possibility of this considerable modification is confirmed by the fact that the economic environment of the plant is promising: the domestic demand is high, varieties of higher yield potential (3 tons ha⁻¹) have appeared, and the buying-in prices are favourable - it can be concluded that a high turnover per ha can be achieved with this plant. The agri-environmental management programmes as well as the 'greening', a key element of the Common Agricultural Policy (CAP) also favour growing conditions, the cultivation of dry beans. In addition to the production environment, in recent years a trend in agriculture is - in addition to traditional arable crops - the search for alternative solutions with the possibility of growing intensive, high-turnover crops. Here, however, there is a significant risk of lacking a well-developed, widely known technology that can nuance

growers' interest. To sum up, the dry bean is among the possible alternative crops with all pros and cons mentioned.

At present, dry bean production does not have a comprehensive, complex cultivation technology. The reason – and the consequence at the same time – is its very variable profitability, mainly due to the average yield which can be 30-40% lower than the potential due to the current procedures in use. In addition to the alternation of turnover, high cultivation costs are a significant problem, of which irrigation represents a significant share (SCHERER, 2019). Retaining moisture in the soil and protecting soil at the same time is a task that cannot be fulfilled with the current conventional technologies consisting of 4-5 tillage steps, in the course of which 8-20 mm of moisture per operation is removed from the soil. Conservation tillage, e.g. strip-tillage, however, can be efficiently used also in dry bean (OSORNO ET AL., 2019). On the other hand, to prevent *Fusarium* root rot, *Fusarium* wilt, *Rhizoctonia* root rot or *Sclerotinia* root rot infection, deep ploughing is recommended (LIEBENBERG, 2002). The higher-yielding dry bean varieties appeared recently also require new production strategies, even precision cultivation methods to fully utilize their genetic potential.

Here we report on the result of our experiment of comparing the effects of different primary tillage strategies on the yield of dry bean.

MATERIALS AND METHODS

The effects of three different primary tillage methods (inversion, non-inversion and strip-tillage) were compared in a farm-size experiment in Szeged, South-East Hungary. The three fields each were ca. 1.4 hectares in size. The soil analysis showed that the alluvial soil of the experimental area was mid-heavy, belonging to the loam and clay loam physical group. The humus content (1.6-2.4%) was poor/average, the AL-soluble P₂O₅ content (256-604 mg kg⁻¹) very good, while the AL-soluble K₂O content (271-491 mg kg⁻¹) between average and very good. The research was established in one growing season (2020), with the bean variety 'Marquis' of the 'Great Northern' type. Inversion tillage was done with a reversible plough at also 30 cm depth. Non-inversion tillage was performed with a field cultivator at 30 cm depth. For strip tillage, an Orthman 1tRIPr strip-till cultivator was used to prepare the soil for seeding in one pass, in a width of 25 cm and a depth of 30 cm along the rows. Sowing was performed on 30th April 2020 at a 70 cm row distance, with a seed rate of 250,000 ha⁻¹. The established plant density was determined on the 4th week. For the calculation of yield elements, five random samples were collected from each field on 15th August, each sample containing 5 plants being in full ripening. The following parameters were determined in laboratory: number of pods per plant, number of seeds per pod, thousand-grain-weight. The number of established plants per hectare was determined *in situ*, based on the number of plants per running meter in 23-26 sample areas per treatment.

For statistical analysis, analysis of variance and LSD as well as Tukey tests were done with the IBM SPSS Statistics software.

RESULTS

The yield components determined in the laboratory were statistically evaluated with the results summarized in *Table 1*. The values for the number of pods per plant, the seeds per pod and thousand grain weight did not show significant differences by ANOVA but each

case the strip-tillage gave the highest results. The numbers of established plants, as calculated data, show significant differences in an indirect way: the number of plants per hectare for the strip-tillage was ca. 40% of those for the other two methods (*Table 1*).

Table 1. The effect of various tillage methods on the yield components of dry bean

Tillage method	Yield component			
	Pods per plant (No.)	Seeds per pod (No.)	Thousand grain weight (grams)	Established plants per hectare (No.)
Inversion	14.56±1.24a	3.84±0.14b	331.4±12.46c	143,000d
Non-inversion	14.92±1.14a	3.78±0.14b	322.4±8.09c	143,000d
Strip	17.88±1.92a	4.10±0.16b	336.6±20.47c	57,000e

The values show the mean and the standard error, the same letters mean no significant difference ($p \geq 0.05$).

Based on the pods per plant, seeds per pod and thousand grain weight values, the calculated yield per plant turned out to be significantly different between the strip-tillage (24.35 ± 1.99 grams plant⁻¹) and the other two methods, strip-tillage giving the best result. The values for inversion (18.57 ± 1.89 grams plant⁻¹) and non-inversion (18.33 ± 1.61 grams plant⁻¹) tillage did not differ significantly, although, the inversion tillage showed higher values (*Figure 1*).

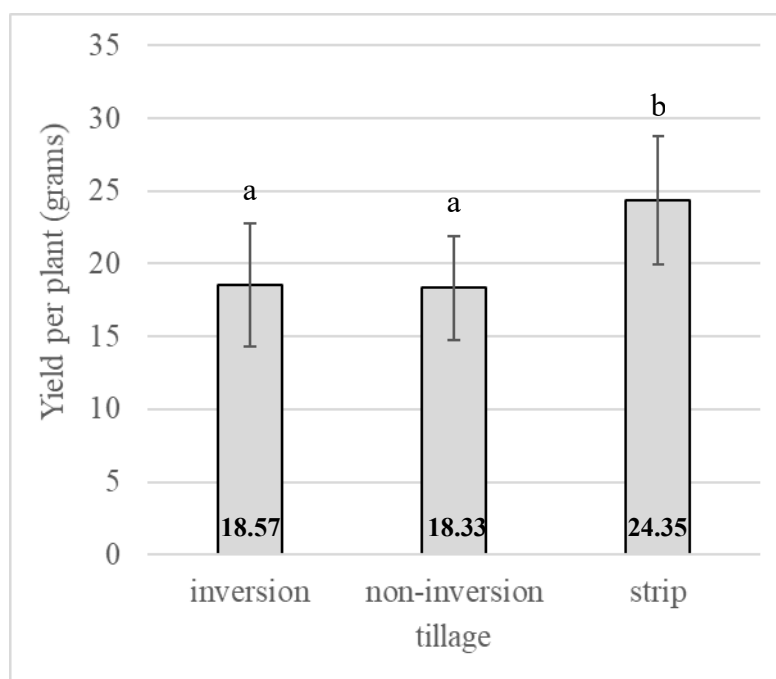


Figure 1. The effect of various tillage methods on the yield per dry bean plants. The bars represent standard deviation (n=5), the different letters indicate significant differences by Tukey test ($p < 0.05$).

In the case of calculated yield per hectare, the tendencies changed. The yields for inversion (2.66 ± 0.27 tons ha⁻¹) and non-inversion (2.62 ± 0.23 tons ha⁻¹) tillage were not different significantly, while strip-tillage gave a significantly lower yield (1.39 ± 0.11 tons ha⁻¹), ca. half the value of the other treatments (*Figure 2*).

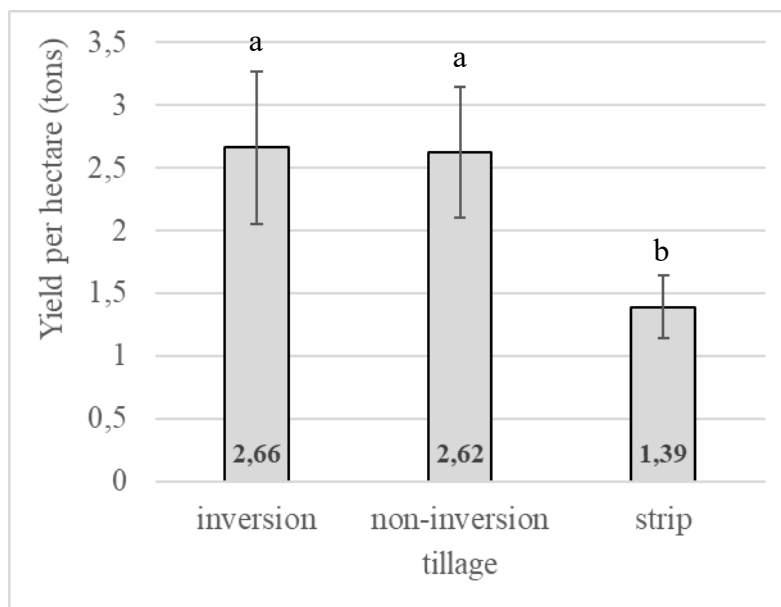


Figure 2. The effect of various tillage methods on the dry bean yield per hectare. The bars represent standard deviation (n=5), the different letters indicate significant differences by Tukey test ($p < 0.05$).

DISCUSSION

In our experiment, there could be found no significant differences between the yield component and yield data of inversion and non-inversion tillage methods. Strip-tillage, however, resulted in significantly higher values for almost all parameters compared to the other two methods. As the plant density was significantly lower for strip-tillage, despite the significantly higher yield per plant, the yield per hectare results became the lowest. From the conditions detected at the establishment of plants, it seemed to be obvious that - in spite of the supposed to be proper setting of the driller - the harmonization of strip-tillage and sowing was not perfect. As the higher yield component and yield per plant data can be explained both by the lower plant density and the superiority of strip-tillage, the repetition of the experiment is essential.

In our experiment - to adapt the setup to the basic setting of the strip-till cultivator - 70 cm row spacing was applied throughout. In Hungary, a medium row spacing of 45-55 cm is usual (KÉSMÁRKI, 2005; SZABÓ, 2019) while in the US dry bean is sown at a variety of row distances between 53.34 and 76.2 cm (21-30 inch), the most common being 55.88 cm (22 inch) (OSORNO ET AL., 2019). A decrease from 76.2 cm (30 inch) to 38.1 cm (15 inch) row spacing could result in either no significant difference or considerable increase in yield (HALSALL, 2018). Cutting down on seed expenses and lower disease risk can be achieved by reducing seed rates. A 20 per cent reduction in seeding rates can result in minimal yield loss if the crop is planted early or on time (HALSALL, 2018). For 'Great Northern' type beans a population density of 173-198,000 per hectare is recommended in the US (OSORNO ET AL., 2019). In Hungary, an earlier cultivation guide recommends - depending on variety - a seed rate of 350-500,000 per hectare and calculates with a stand loss of 15-25% that means a final plant density of ca. 260-425,000 per hectare (KÉSMÁRKI, 2005). Similarly, a

more recent work finds a final plant density of 250-300,000 per hectare being optimal (SZABÓ, 2019). In our experiment, after seeding at a rate of 250,000 per hectare the final plant density was between 57,000 and 143,000 per hectare, due to the high losses (>40%, data not shown) at emergence.

Our results show that dry bean can be successfully grown by using various primary tillage strategies as well as broader row spacing than usual. The equal utility of inversion and non-inversion tillage is confirmed by the non-significant results while the strip-tillage must be evaluated in a repeated experiment. Regarding row spacing, although higher row spacing results in lower yield, it can be compensated by the lower investment in the seed being relatively expensive in the case of dry bean varieties.

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RESEARCH ON LEG TAGS IN GOAT BREEDING FOR ELECTRONIC IDENTIFICATION PURPOSES

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ABSTRACT

This study is on the fall and readability of electronic leg tags, plastic ear tags and electronic ear tags used in 2 flocks of goats. Honamlı and Turkish Hair goat flocks were followed for 4 months and bred under different conditions. While the flock of Honamlı goats went to pasture every day, the Turkish Hair goats remained indoors. It was found that the leg tags fell from 5 goats in the Honamlı flock (96%), while none fell in the Turkish Hair flock. Plastic ear tags attached to goats were found to have fallen from 11 goats (92%) in the Honamlı flock and 7 goats from Turkish Hair goat flock (90%). The readability of electronic leg tags, plastic ear tags and electronic ear tags used in goats for 4 months was determined as 100%. It is useful to carry out research on the use of electronic leg tags as an alternative option for goat breeding for identification purposes, with different trial groups formed on animals of different ages and different legs.

Keywords: Goat, identification, electronic, plastic, leg tags

INTRODUCTION

There were 37 276 050 sheep and 11 205 429 goat in Turkey in 2019 (TURKSTAT 2021). It is obligatory by regulation EC 21/2004 to identify sheep and goats which will be transported among the Member States of the European Union or to be shipped to third countries and to be able to monitor animal movements. According to the regulation, it has decided to use a double identifier in sheeps and goats. The first is at least 1 electronic descriptive bolus or electronic ear tag; Second, the visible identifier ear tag used for marking with traditional plastic ear tags, tattoos or paint are similar across the EU (EU2004). Today, most electronic id (e-ID) devices in use in the field of animal husbandry (ruminal bolus, e-RB, electronic ear tags, eET; electronic leg tags, e-LT or injectable transponders, e-IT) are considered effective tools for linking animal identity to information and performance data (TREVARTHEN AND MICHAEL, 2007; VOULODIMOS ET AL. 2010). It's been reported that electronic ear tags, bolus, leg tags and injectable chips were used for electronic identification purposes along with the use of plastic ear tags in goats. Foot bands are recommended only for adult dairy goats under intensive conditions. Although there are situations of loss related to foot bands, it has been concluded that they are available in the long term (CAJA ET AL. 2014). ABECIA AND PALACIN (2014), reported that he type of production systems in small ruminant breeding is an important factor to consider when choosing an electronic label. They reported that their extensive system can reduce the retention of foot bands. It has been reported that it is appropriate to wear foot bands after lambs and kids are at least 6 months old (40% of adult live weight).

The aim of this study is to determine the retention and readability of electronic leg tags, plastic ear tags and electronic ear tags used in 2 flocks of goats raised under different conditions for 4 months.

MATERIALS AND METHODS

This research is a part of project supported by Burdur Mehmet Akif Ersoy University, which was selected as the pilot university in the field of "Regional Development Focused Mission Differentiation and Specialization" project studies coordinated by the Higher Education Council and Presidency Strategy and Budget Directorate: Increasing the Sectoral Competitiveness of Burdur Province: Integrated Development by Differentiating in Agriculture and Livestock. It consists of some data (Department of Animal Science) obtained under the subproject titled and number "Dissemination and Small Ruminant Breeding 2017K12-41003-2". The study was carried out in Burdur Mehmet Akif Ersoy University, Agriculture, Livestock and Food Research and Application Center, Small Ruminant research unit.

In this study, 122 Honamli goat and 55 Turkish Hair Goats were used. In some animals, plastic ear tags are worn in pairs. When this study on different identification began, the goats were of different ages. Twenty-one of the animals in the Honamli flock are 8 months old and 101 are between the ages of 2 and 8 years. Thirty-two of the hair goats were 8 months old and 23 were between the ages of 2 and 8 years. All of these goats had plastic Eartags implemented by Ministry of Agriculture and Forestry. Most of them also had RFID eartags also implemented by Ministry of Agriculture and Forestry. All goats reared in the University farm also had two plastic eartags but not all of them were left at the start of this study. This study was conducted for 4 months between December 2020 and April 2021. At the start of this study RFID leg tags were applied to all of the animals. Leg tags were placed on the, around the metatarsus, covering the entire region (*Figure 1*). Each type of tags is checked periodically and total number of each type of tags noted. While the flock of Honamli goats went to pasture every day, the Hair goats remained indoors. In monthly periodic checks, goats who lost identification tools were detected by cross-checking various identification methods.

RESULTS

During this research, the results of the use of electronic leg tags applied in the flock of Honamli goats that are taken out every day in (*Table 1*). Turkish Hair goat flock kept inside are given in (*Table 2*). According to the results, it was determined that at the end of 4 months, leg tags fell from 5 goats in the Honamli flock (96% retention), and Turkish Hair goats did not loss any. In the Honamli goat flock, 2 of the animals whose electronic ankles fell are 4 years old, 2 are 3 years old, and 1 is 2 years old. However, Plastic ear tags attached to goats were found to have fallen from 11 goats (92% retention) in the Honamli flock, and 7 goats in Turkish Hair goats (90% retention) (*Table 3 and 4*). It was determined that among the Honamli goats that lost their plastic ear tags 1 animal was 8 months old and 10 animals were 2 years and older. In Hair goats each 7 of them was older than 2 years of age. 7 Honamli goats which lost their electronic ear tags (87% retention) one of which is 8 months old and 6 is over 2 years of age. 2 Turkish Hair goats lost their electronic ear tags both of which over 2 years old. The readability of electronic foot bands, plastic ear earrings and electronic ear earrings used in goats for 4 months was determined as 100%.

Table 1. Retention and readability rates of Foot Band EIDs recorded on Honamlı goat Flock (goats, outdoors)

Honamlı goat Flock (goats, outdoors) ^(a)	Tagged ^(b)	Retained	Retention	Read	Readability
0 days	122	122	100%	122	100%
30 days	122	119	98%	119	100%
60 days	122	118	97%	118	100%
90 days	122	117	96%	117	100%
120 days	122	117	96%	117	100%

Table 2. Retention and readability rates Foot Band EIDs recorded on Turkish Hair goat (goats, indoors)

Turkish Hair goat Flock (goats, indoors) ^(a)	Tagged ^(b)	Retained	Retention	Read	Readability
0 days	55	55	100%	55	100%
30 days	55	55	100%	55	100%
60 days	55	55	100%	55	100%
90 days	55	55	100%	55	100%
120 days	55	55	100%	55	100%

Table 3. Retention and readability rates of Plastic Eartags applies by government recorded on Honamlı goat Flock (goats, outdoors)

Honamlı goat Flock (goats, outdoors) ^(a)	Tagged ^(b)	Retained	Retention	Read	Readability
0 days	132	132	100%	132	100%
30 days	132	123	93%	123	100%
60 days	132	121	92%	121	100%
90 days	132	121	92%	121	100%
120 days	132	121	92%	121	100%

Table 4. Retention and readability rates Plastic Eartags applies by government recorded on Turkish Hair goat (goats, indoors)

Turkish Hair goat Flock (goats, indoors) ^(a)	Tagged ^(b)	Retained	Retention	Read	Readability
0 days	71	71	100%	71	100%
30 days	71	64	90%	64	100%
60 days	71	64	90%	64	100%
90 days	71	64	90%	64	100%
120 days	71	64	90%	64	100%

Table 5. Retention and readability rates of EID Eartags applies by government recorded on Honamlı goat Flock (goats, outdoors)

Honamlı goat Flock (goats, outdoors) ^(a)	Tagged ^(b)	Retained	Retention	Read	Readability
0 days	55	55	100%	55	100%
30 days	55	55	100%	55	100%
60 days	55	54	98%	54	100%
90 days	55	49	89%	49	100%
120 days	55	48	87%	48	100%

Table 6. Retention and readability rates EID Eartags applies by government recorded on Turkish Hair goat (goats, indoors)

Turkish Hair goat Flock (goats, indoors) ^(a)	Tagged ^(b)	Retained	Retention	Read	Readability
0 days	21	21	100%	21	100%
30 days	21	19	90%	19	100%
60 days	21	19	90%	19	100%
90 days	21	19	90%	19	100%
120 days	21	19	90%	19	100%

Retention = no. retained tags / (no. tagged tags - no. sold or dead tagged animals)

Readability = no. read tags / no. readable tags

(a) Days after tagging

b) Differences on subsequent reading dates due to dead or sold animals



Figure 1. Electronic leg tag used in the experiments (Prof. Dr. Özkan Elmaz)

DISCUSSION

In the study of ABECIA AND PALACIN (2014), the rate of staying in animals in a completely closed area was determined as 100%. It is similar to the results in this study. On the other hand, the 90th day stay rates of animals living completely outdoors were determined as 94.5% and 78.2% in two herds, which is higher than the result obtained as 96% in this study. However, in the study of ABECIA AND PALACIN (2014), the retention rate in animals until the 180th day decreased to 63% and 78.2%, indicating that longer-term studies should be conducted. CARNE ET AL. (2010), in their study on the dairy Murciano-Granadina goat breed, it was reported that there was no loss of footband and all of them could be read visually, but 3 goats (1.5%) had to be removed due to limping, and this had 98.5% retention of the footband. In addition, in 7 goats (3.6%) the foot straps were found to be open and not electronically readable. These results are similar to the findings about the Honamli goat herd in the study. The drop and reading rates of electronic and plastic ear tags reported for the same study were found to be higher than the values.

For identification purposes, it is beneficial to conduct researches on the use of electronic foot straps as an alternative option in goat breeding by establishing different experimental groups on animals of different ages and foreleg and hind legs.

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RESEARCH ON THE GROWTH OF KIDS IN GOAT BREEDING WITH GOOD FLOCK MANAGEMENT: PILOT VILLAGE BEŞKAVAK MODEL*

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ABSTRACT

This study was carried out to demonstrate the effect of "Good Flock Management" on the growth characteristics of goats. Studies conducted in the province of Burdur in Turkey under "Focused District Development Project". Goat flocks were in Beşkavak village which was selected as a model village, were used in the study. The study was carried out in 2019 in two goat flocks. The birth weights of the male and female kids were determined as 4.04 kg and 3.58 kg and 4.09 kg and 3.52 kg respectively for the first and second flock. On the 90th day of the first and second flock, the live weight values of male and female kids were determined as 17.68 kg and 14.17 kg and 19.81 kg and 16.94 kg respectively. Single born kids' live weight value on the 90th day in flock 1 determined as 15.85 kg.

Keywords: Flock management, kids, growth

INTRODUCTION

The formation of the animal production of Turkey's developing infrastructure for small animals is quite overflowing importance (BİNGÖL ET AL. 2011). In Turkey, as of the end of June 2020, the number of goat was recorded as the number of goats as 12 million 351 thousand (TURKSTAT, 2020). When we look at Turkey's economy in goat breeding, traditional, inefficient but fields not suitable for crop production is useable for small ruminants which makes it very important. Today, however, significant reduction in the number of small animals Turkey, with the fall in yields occurred. Consequently, the products obtained from these animals also decreased and the breeders were affected negatively by this situation. (ERTEN AND YILMAZ 2013). Growth; It is the most important feature of the creature and is defined as the increase in both weight and size over a period of time (ÖZDEMİR AND DELLAL 2009). ELMAZ ET AL. (2020), within the scope of the Public Breeding Project, examined the growth data of 22817 kids born in a five-year period (2012-2016) and 21643 kids reaching the 90th day in their study on the Hair goat flocks raised in Antalya. The mean birth weights of the kids born in 2012, 2013, 2014, 2015, and 2016 were determined as 3.38, 3.41, 3.26, 3.32, and 3.26 kg, and also the mean live weights of 90th day (weaning) were found as 16.96 kg, 18.33 kg, 17.43 kg, 17.47 kg, and 17.53 by the years, respectively. ELMAZ ET AL. (2012), The average birth weight for the Honamlı kids was 4.1 and 3.7 kg, respectively. In a study carried out on Hair goats raised completely in extensive conditions in Aydın province, the live weights (kg) of born goats at birth, 1st month, 2nd month, 3rd month, 4th month, 5th month and 6th month respectively; It has been determined as 2.58 kg, 6.36 kg, 9.75 kg, 13.58 kg, 17.32 kg, 20.45

kg and 22.40 kg (ORAL AND ALTINEL 2006). In the study, in which some yield characteristics of Hair goat goats raised under extensive conditions in the same province up to 8 months old were examined; Live weights at birth, 3rd, 6th and 8th months were found to be 2.19 kg, 13.08 kg, 20.25 kg and 23.32 kg, respectively (ORAL TOPLU AND ALTINEL 2008). In another study performed in pure Bristle goat flock and Saanen x Hair goat crossbred goats raised under breeding conditions, the average birth weight of goats was reported as 2.63 kg and 3.70 kg (ŞENGONCA VE ARK., (2003).

This study was carried out to determine the growth traits of Turkish Hair goat kids applied to good flock management.

MATERIALS AND METHODS

This research is a part of project supported by Burdur Mehmet Akif Ersoy University, which was selected as the pilot university in the field of "Regional Development Focused Mission Differentiation and Specialization" project studies coordinated by the Higher Education Council and Presidency Strategy and Budget Directorate: Increasing the Sectoral Competitiveness of Burdur Province: Integrated Development by Differentiating in Agriculture and Livestock. It consists of some data (Department of Animal Science) obtained under the subproject titled and number "Dissemination and Small Ruminant Breeding 2017K12-41003-2" from pilot village Beşkavak's 2 goat holding.

When starting to work, first of all, farm owners were given trainings on all kinds of applications during mating, pregnancy, birth and growth periods by the expert team involved in the project. Flock lists prepared in order to keep birth records regularly were distributed and how to keep records was explained in detail and in practice. All processes were checked regularly by project experts throughout the year. During this period, applications for vaccination, parasitic applications and similar protective measures were performed in a controlled manner in the flock.

The present study was carried out in two Hair goat flocks reared under local breeder condition in Beskavak district of Burdur province in Turkey. The birth weights, live weights on the 30th, 60th and 90th days of age of totaly 281 kids were defined. The interpolation was used for measurement periods for growth characteristics. The kids in two flocks were kept under the same care-feeding conditions in the same environment.

In the statistical comparison of the data, 16.1 version of Minitab statistical packaged software was used (MINITAB, 2011). A statistical model with the fixed effects (sex and birth type) was used for determining the Least-square means of the examined traits for flock 1. Additionally, The Student-T test was employed the defined differences between Hair male and female kids for flock 2.

RESULTS

Table 1 shows the growth performances of Turkish Hair kids in flock 1. Based on sex, the birth weights of male and female kids were determined to be 4.04 kg and 3.58 kg, respectively. While the live weights at the 30th, 60th and 90th days of age were 8.59 kg, 13.13 kg and 17.68 kg for male kids, these values were respectively 7.11 kg, 10.64 kg and 14.17 kg for female kids. There were significant differences, except at birth for live weights between male and female kids ($P < 0.05- 0.001$). In addition, As seen from Table 1, while single kids were observed to reach higher values in terms of birth and live weights compared to twin birth kids, differences between birth type groups were not found to be a statistically significant ($P > 0.05$).

Table 1. Least square means for the effects of sex and birth type on live weights of Turkish Hair kids in the different periods in flock 1 (kg) ($\bar{x} \pm s_x$)

Factors	n	Birth weight (kg)	30th days	60 th days	90 th days
Sex					
Female	59	3.58 ± 0.07	7.11 ± 0.15	10.64 ± 0.26	14.17 ± 0.36
Male	69	4.04 ± 0.65	8.59 ± 0.15	13.13 ± 0.26	17.68 ± 0.37
P		ns	*	***	***
Birth type					
Single	92	3.83 ± 0.05	7.84 ± 0.13	11.85 ± 0.22	15.85 ± 0.31
Twin	36	3.20 ± 0.20	7.18 ± 0.63	11.16 ± 1.08	15.13 ± 1.52
P		ns	ns	ns	ns
Overall	128	3.80 ± 0.05	7.80 ± 0.13	11.81 ± 0.22	15.81 ± 0.31

ns: nonsignificant ($P > 0.05$). *: $P < 0.05$, **: $P < 0.01$, ***: $P < 0.001$.

Growth performances of Turkish Hair male and female kids from birth until 4 months of age were presented in Table 2 for flock 2. When this table was examined, the live weights at birth, 30th, 60th and 90th days of age were 2.75 kg, 8.44 kg, 14.13 kg and 19.81 kg for Hair male kids, these values were respectively 2.40 kg, 7.25 kg, 12.09 kg and 16.94 kg for female kids. Similar to flock 1, There were significant differences, except at birth for live weights between male and female kids ($P < 0.05$ - 0.001).

Table 2. Live weight values of male and female Turkish Hair kids in the different periods in flock 2 (kg) ($\bar{x} \pm s_x$)

Factors	n	Birth weight (kg)	30th days	60 th days	90 th days
Sex					
Female	76	3.52 ± 0.06	7.25 ± 0.16	12.09 ± 0.30	16.94 ± 0.44
Male	77	4.09 ± 0.08	8.44 ± 0.17	14.13 ± 0.31	19.81 ± 0.45
P		ns	*	***	***
Overall	153	3.79 ± 0.05	7.85 ± 0.13	13.12 ± 0.23	18.38 ± 0.33

ns: nonsignificant ($P > 0.05$). *: $P < 0.05$, **: $P < 0.01$, ***: $P < 0.001$.

DISCUSSION

The birth weight and live weights on the 90th days of flock 1 kids determined by this study were higher than values reported by some researcher (ŞENGONCA ET AL. 2003; ORAL AND ALTINEL 2006; ORAL TOPLU AND ALTINEL 2008). In other studies, the average birth weights of Honamlı kids which was similar to the findings of the current study (ELMAZ ET AL. (2012).

The birth weight of kids in flock 2 was lower than reported values in prior studies (ŞENGONCA ET AL. 2003; ELMAZ ET AL. 2020). and it was similar to the value stated by the study of (ORAL AND ALTINEL 2006; ORAL TOPLU AND ALTINEL 2008).

The results of the current study showed that Turkish Hair kids applied to good flock management had a similar to birth weight and live weights than the other goat breeds and similar breed in Turkey. Therefore, this study could be used as a model in goat breeding within the Teke region of Turkey. Additionally, it is considered that the income of local people may be increased by implementing planned applications and the regular recording studies.

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CASE STUDY ON THE REGISTRATION OF NAGYKUN RICE PGI**LILI JANTYIK**

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ABSTRACT

With various producer subsidies and giving more information for the consumers, at least a part of the European rice market can be independent of the Asian market. The consumer encounters more and more information on the packaging of food products, among others, the GI label. Geographical Indications contain information on both the origin of the food and the quality associated with the origin. The Nagykun Rice Consortium in Hungary aimed at the European Union geographical indication to highlight the values of Nagykun rice. There were several reasons for the demand for PGI designation. The 2013 Land Act stipulates that those who are engaged in the production of GI product are entitled to pre-emption, so one of the reasons was to keep the lands what they use already or be the one who can buy a new one first. Another reason was that they had been using organic label for several years, so based on their experience, they were also aware of the marketing opportunities of the new label. Important features of Nagykun rice for consumers are the extremely low level of arsenic and the fact that the product is 100% gluten free. The introduction of the organic label was a good example of increasing the price and, as a result, producers can hope that the PGI label can also increase the price among conscious consumers in long-term. The PGI registration process itself is relatively long, but government bodies have proven to be supportive and helpful. The PGI label can be a long-term profitable investment in the Hungarian rice sector. The case of the Nagykun rice consortium can be a good example not only for other rice producers, but also for producers of other agricultural products.

Keywords: PGI, PDO, GI, rice cultivation, rice production

INTRODUCTION

Although rice cultivation is not as strategically important agricultural sector in Europe as it is in some Asian countries, it is not a negligible crop as rice consumption is constantly increasing in Europe as well. The European Union and each Member State use various incentives to decouple at least a portion of domestic consumption from Asian imports. In addition to the various producer subsidies, it is important to inform consumers about the benefits of rice grown in Europe. Consumers around the world can find more and more labels on food product packaging. One such category is geographical indications, which are becoming increasingly important with the emergence of conscious consumers for whom the social and ethical characteristics of products are important (BRIGGEMAN AND LUSK, 2010). The European Union distinguishes between two types of designation: a protected designation of origin (PDO) and a protected geographical indication (PGI). The main difference between the two indications is that the PDO product is entirely linked to a specific geographical area, while the reputation of PGI products is from the fact that at least a significant part of their production tied to a particular location. Several previous studies have shown that geographical information carried with food can influence consumers' food choices, for example in the GI cheese market (CERNEA, 2011) or in the GI apple market (FOTOPOULOS AND KRYSTALLIS, 2003). Some studies have also made analysis of the geographical indication rice market. For example, LEE ET AL. (2020) examined the willingness to pay a premium for GI jasmine rice in Thailand. Jasmine rice (also known as Hom Mali rice) is preferred on the international market for its unique

aromatic soft and sticky texture (SUWANNAPORN AND LINNEMANN, 2008). Jasmine rice from the Thung Kula Rong-Hai region is said to have an even more outstanding aroma due to the special weather and salinity of the area and the traditional processing method. In the EU, it gained the PGI label in 2013 as Khao Hom Mali Thung Kula Rong-Hai. The availability of rice products with this certification label in the Thai market was limited in retail because only a few producers were able to comply with the standards and practical rules required by the certification scheme for PGI. In January 2017, the authors found only two brands with a Thai geographical indication and an EU PGI certificate on the Thai market. In processing the systematic literature on geographical indications, TÖRÖK AND MARÓ (2020) found four articles on rice. These studies were also conducted in Asian countries. JENA AND GROTE (2012) concluded in India that Basmati rice production is more profitable compared to other rice varieties and that the acceptance of Basmati rice as a PGI has increased household welfare. NGOKKUEN AND GROTE (2012) found that in Thailand, producers of PDO jasmine rice have a better bargaining position than producers of non-GI products. JENA ET AL. (2015) examined the situation of geographical indications and rice producers in India and Thailand. The research concluded that certification has a major role to play in reducing rural poverty. The European Union's E-Ambrosia database of GI products contains 14 GI rice products. These products belong to the food category "1.6. Fruit, vegetables and cereals, fresh or processed". Two non-EU countries (India and Thailand) have also registered a protected geographical indication for their local rice. The list also includes Spanish, Portuguese, Italian and French rice varieties with both PDO and PGI designations. The oldest GI rice was registered in 1996, while the last is Nagykun rice, which is expected to reach the end of the registration process in 2021. There is only a limited literature on both European and Hungarian rice cultivation but using these and mostly the interview with the largest Hungarian rice producer, who are producing also the Nagykun rice, the study analyzes the possible effects of geographical indications on the Hungarian rice producers.

MATERIALS AND METHODS

Just a few companies in Hungary are engaged in rice production, and only the largest rice producer in the country is interested in the possible benefits of geographical indications. Therefore, the case study approach was chosen as the methodology of the research, which according to GERRING (2004) definition is an intensive study of a single unit in order to understand and generalize to a larger group of (similar) units. Based on this, with the examination of the largest domestic rice producer, the expectations of the producers of GI products will be presented. Producers of other agricultural GI products can also draw conclusions from this case. As a first step, the previous literature was used, then the information received from the Hungarian Rice Growers' Association was analyzed. The Association of Hungarian Rice Growers was questioned by e-mail about the issues that concern them. The next step was an in-depth interview with the largest rice producer in Hungary and the only company producing the future Nagykun rice PGI product. An employee of Nagykun 2000 Mezőgazdasági Zrt. was interviewed, who is responsible for production, in two parts by phone on 3rd and 4th February in 2021. The questions focused on the processes of introducing a geographical indication and the expectations associated with the label.

RESULTS

The largest domestic rice producer

In order to give a complete picture of the surveyed company, first their publicly available company data was analyzed. Then the further questions were clarified during an interview with a company expert. From the publicly available company data, Nagykun 2000 Mezőgazdasági Zrt. was registered on 31st March 2000, as the legal successor of the "NAGYKUN" Agricultural Cooperative. The headquarter of the company is in Kisújszállás. From the company's statement, we can see that it has operated successfully with about 120 employees in the recent years. It was able to increase its net sales year by year, even though the value of export sales halved in 2018 compared to the previous year. The value of the company's profit before tax also shows a successful operation. The interview revealed that the company (and its many legal predecessors) have been farming in their current areas since the 60's-70's. Already in these early years, they were engaged in rice cultivation, but since then new rice plantations have been continuously established. The company cultivates about 4,400 hectares, of which about 1,660 hectares are built-up rice area (about 1,000 hectares of rice each year, 660 fallow). The lands typically have a value between 40 and 10 AK (AK: Hungarian special land classification value number), they are located in the vicinity of Kisújszállás from Ecsekfalva to Kendres. The two farthest areas are 30 km apart. In addition to rice, other crops are also grown, such as wheat, barley corn, sunflower, canola, mustard, soybeans, etc. In addition, the company operates a dairy farm with 350-400 animals. In terms of processing, they only deal with rice, the rest of the grain is sold, except for the smaller quantities that are used as forage in dairy farming. The company has an equipped fleet of machines. In terms of sales, in most cases the rice is purchased from them in packs of one or a half kilogram, but for further processors, packs of 20 kg are also available. In all cases, the rice is direct sold whether it is restaurants or chain stores. Among others, their products are sold in Spar stores, both in commercial and private label packaging. They are not sold directly to retailers abroad, but organic rice is also sold to Germany, mainly to produce infant food.

Nagykun rice PGI

The applications for PDOs and PGIs are not made by a single company, but by a producer group or a consortium. In the case of Nagykun rice, this is the Nagykun rice Consortium, which, if not by such a name, already existed before the PGI application. 3-4 local companies are involved to the Consortium, but Nagykun 2000 Mezőgazdasági Zrt do the agricultural work and sales, the other companies only play an ownership role. Thus, in the case study, the Nagykun Rice Consortium and Nagykun 2000 Mezőgazdasági Zrt. were not separated, as we can essentially talk about one entity in terms of work processes. At the end of June 2017, the Nagykun Rice Consortium has applied to the Hungarian authorities for the designation of the Nagykun rice product as a protected geographical indication. The application was accepted by the Hungarian authority in 2018, so currently the Nagykun rice PGI is an agricultural product under temporary national protection, EU recognition is ongoing by the European Commission. The full registration process can be found in detail in Regulation (EU) No 1151/2012 of the European Parliament and the Council. There were several reasons for the demand for PGI designation. In the past, the land used by the Nagykun Rice Consortium has been purchased many times, but the 2013 Land Act defined that those involved in the production of a product with a geographical indication have a pre-emption right. Another reason was that the company had been using the organic labeling for several years, so based on these experiences, they were also aware of the marketing opportunities of these type of labels. The product description of the application

for registration of Nagykun rice PGI contains a detailed description of the characteristics of Nagykun rice. It has been determined which plant varieties can be used as raw materials for “Nagykun rice” PGI: M-225, M-488, Fruzsina M, Sandora, Dáma, Risabell, Janka, Ábel, Bioryza. The interview revealed that only Hungarian varieties were considered. Based on many years of experience, these are the varieties which can be best utilized in this growing area. The most important expectation in choosing a variety is the highest possible yield, combined with the lowest possible risk factor. Unfortunately, the Hungarian varieties have dropped behind in genetic innovation in recent years compared to foreign varieties. An important feature in the selection of varieties was that the technological line was built on these types of rice not for e.g., on round-grained rice. The Nagykun Rice Consortium uses 60% Hungarian varieties and 40% Italian rice varieties. The description of the application for PGI registration places the production area in the northern part of Nagykunság in Jász-Nagykun-Szolnok county. Of course, the exact method of production is also described in the document, from tillage to packaging, as well as labeling requirements. Other very important characteristics of 'Nagykun rice' for consumers are that the arsenic content has been set at an extremely low level, up to 0.1 mg / kg, which is much below the EU limit. The product must also be 100% gluten-free. The soil of the production area is well supplied with the mineral elements necessary for growing rice, but the biologically harmful heavy metals are present at extremely low levels. Rice contains, on average, ten times more inorganic arsenic than most foods. There are only a few suitable arsenic-free rice-growing areas in Europe. The low arsenic content measured in the case of 'Nagykun rice' is mainly due to the defined geographical environment, which has a clear impact on the quality of the rice. All this is proved by the long-term and continuous export of “Nagykun rice”, mainly to Germany, to world-famous infant food companies. In the case of rice used in the manufacture of food for infants and young children, the maximum level for inorganic arsenic is 0.1 mg/kg. (NAGYKUN RIZS KONZORCIUM, 2017).

Expectations of the Geographical Indication

Regarding the registration process itself, it was revealed during the interview that the staff from the Ministry was supportive and helpful with the preparation of the PGI designation documentation and the whole process. This greatly facilitated the early stage of the processes. The Consortium has not changed its initial expectations regarding the GI label. they cannot know in advance how consumers will receive the PGI label, but they do not expect the price of rice to rise in the short term if the label is introduced. In their experience, other external economic factors affect consumer prices much sooner, such as the presence of COVID-19, which greatly increases the number of rice buyers as it is a durable product, so producers could have raised their prices. In long term they hope that the number of conscious consumers will be massive in Hungary as well, and then the demand for such and similar PGI products may increase greatly. The Nagykun Rice Consortium does not plan to use the PGI designation for cooperation with any other sector (for e.g., tourism). Future plans for the PGI label can build on their previous good experience with the organic label. In rice areas that have been organically grown (certified by the Biokontroll Hungária Nonprofit Kft.), it is already doubling or tripling the price of the raw material (rice immediately after harvest). The Consortium sells their organic rice products in retail chains in half-kilos or as bulk product to abroad. It is important to emphasize that only Hungarian varieties are used in organic cultivation. Thus, they can rightly trust that Hungarian breeds can achieve success in the long term with this new GI label as well.

DISCUSSION

There are several previous studies, which shown that there is a willingness to pay a price premium for GI labeled products in different categories, such as in the cheese market (CERNEA, 2011) or apple market (FOTOPOULOS AND KRYSTALLIS, 2003). The most recent studies in this topic also find that consumers accepting these GI logos as a marketing tool. For example, DI VITA ET AL. (2021) determining what characteristics consumers would expect for extra virgin olive oil with a PDO label in Italy. TÖRÖK (2019) also examined the expectation of the GI label in case of an agricultural product. The results shows that the possible success of these products is depend on the close cooperation among the producers and the high level of domestic reputation. In short term, a more stable market share would be necessary while on long term increasing prices and export possibilities are expected. The study pointed out that the benefits of GI recognition can only be expected if further improvements will be implemented in the field of infrastructure and marketing. Such studies may give cause for confidence in the introduction of new GI products in the future. Previous research on the rice market has shown that for e.g., in India that Basmati rice production is more profitable compared to other rice varieties and that the acceptance of Basmati rice as a PGI has increased household welfare (JENA AND GROTE, 2012). According to the data, Hungarian rice farmers should focus on the domestic consumers. By highlighting the benefits of the Hungarian rice, they can bargain for a better price for their products, the GI label can be an excellent option for this. The interview and the data show that only a small part of the domestic demand can be satisfied by domestic rice growers, so there is still plenty of potential for growth. The introduction of the organic label was a good example of increasing the price and, as a result, producers can be confident that the PGI label can also increase the price among conscious consumers in the long term. The PGI registration process itself is relatively long, the Nagykun Rice Consortium submitted the application in June 2017 and the process has not been fully completed yet. Government agencies have proven to be supportive of these types of initiatives. Overall, the PGI label can be a profitable investment in the Hungarian rice sector in a long-term. From this case study, we can draw conclusions for other agricultural products that may be worth considering the introduction of a geographical indication.

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THE SIGNIFICANCE OF THE HUNGARIAN WHEAT PRODUCTION IN RELATION TO THE COMMON AGRICULTURAL POLICY

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ABSTRACT

Wheat is one of the most important domestic crops, as well as one of the most important cereals. It has a wide range of use, not only for making basic foods but it is also widely used for animal feeding. The market competitiveness of the production can be measured in different ways. The average yield is one of them, which fluctuates strongly from year to year, mostly driven by weather conditions. Besides, the use of proper seeds and fertilizer, especially nitrogen and potassium, is essential. On the sales side, the price determines the effectiveness of production. Of course, the impacts of the Common Agricultural Policy should not be ignored as direct payments contributed to the gross revenue of crop producers by 57.2% on average. The aim of the article is to present these elements between 2010 and 2020 and to formulate agricultural policy recommendations based on the results obtained. The production and export of higher value-added products, such as various durable foods, but at least seed or durum variety, should be a priority of the Hungarian agricultural policy. This could also stimulate the manufacturing industry, which would have a positive employment effect in addition to an even larger trade surplus. However, the tremendous, 30% price increase in 2021 may not encourage the different stakeholders of the supply chain for any changes.

Keywords: wheat production, international trade, common agricultural policy

INTRODUCTION

Hunger and malnutrition are enormous problems, and 2.8 billion people suffer from them (FAO, 2017). Taking into consideration the continuously growing population, agriculture will face an even higher need for productivity. Hungary has excellent endowments for crops production and achieves a significant trade surplus. However, production suffers from different weather-related problems such as droughts and heatwaves. Nevertheless, wheat has traditionally been an important product of Hungary due to its diverse usability and good market potential.

Besides endowments, it should not be forgotten that the various EU supports play an important role in Hungarian agriculture. In the case of crop producers, direct payments of the Common Agricultural Policy (CAP) have a 57.2% share on average in their gross revenue (KESZTHELYI – KIS CSATÁRI, 2020). This indicates a huge support dependency and questions the overall competitiveness of this sector.

Wheat plays an important role in the Hungarian agricultural trade as production always surpasses domestic consumption. However, its relatively low unit value limits the exportation of the raw material as transportation cost increases proportionally with the distance. Only (further) processing can make it possible to reach distant markets with any crop products.

The article is organized as follows. The next section gives an overview of Hungarian wheat production. This is followed by the characteristics of the Hungarian wheat use. The last section summarizes our results and provides concluding remarks.

Characteristics of the Hungarian wheat production

Wheat is one of the most important crop type in Hungary and its role within cereals is also significant. It is further supported by its high land use share, which is shown in *Figure 1*. Based on this, it can be said that the production area of wheat and maize was almost the same in 2020, so by far, these two are the most significant arable crops. The share of sunflower is roughly half compared to the two above (14%), while rapeseed and various fodder crops are in the other category.

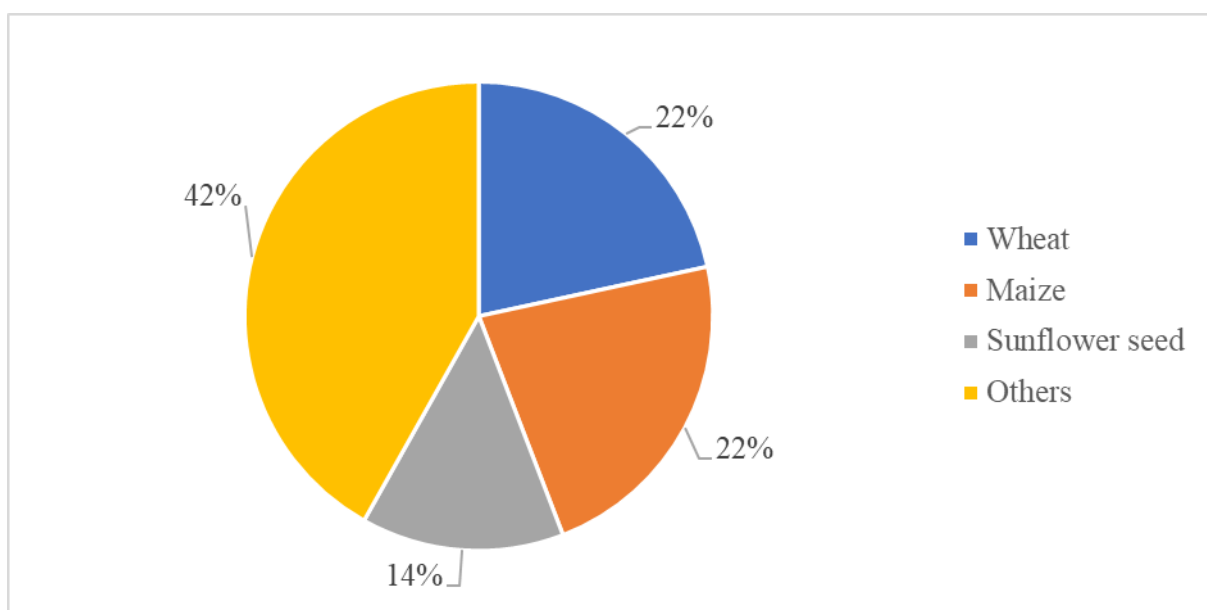


Figure 1. The most important in-land crops, 2020 based on HCSO (2021a) and HCSO (2019) data

The important role of wheat in terms of both supply and demand can be justified by several factors. On the supply side, it is worth highlighting, for example, that the Hungarian arable land is excellent for cultivation, the weather conditions are appropriate, the expertise and significant production experience of farmers are present. On the demand side, the most important aspect is the widespread use of wheat, as it is the raw material for many basic foods (such as bread and various bakery products), feed wheat is an important raw material in livestock breeding, and also its industrial use should not be ignored (ethanol or starch production). As the production level significantly exceeds the domestic market demand, wheat is also an important agricultural export product.

There are two factors of wheat production: the area used for production and the average yield. The development of these two elements is illustrated in *Figure 2* for the last 11 years (2010-2020).

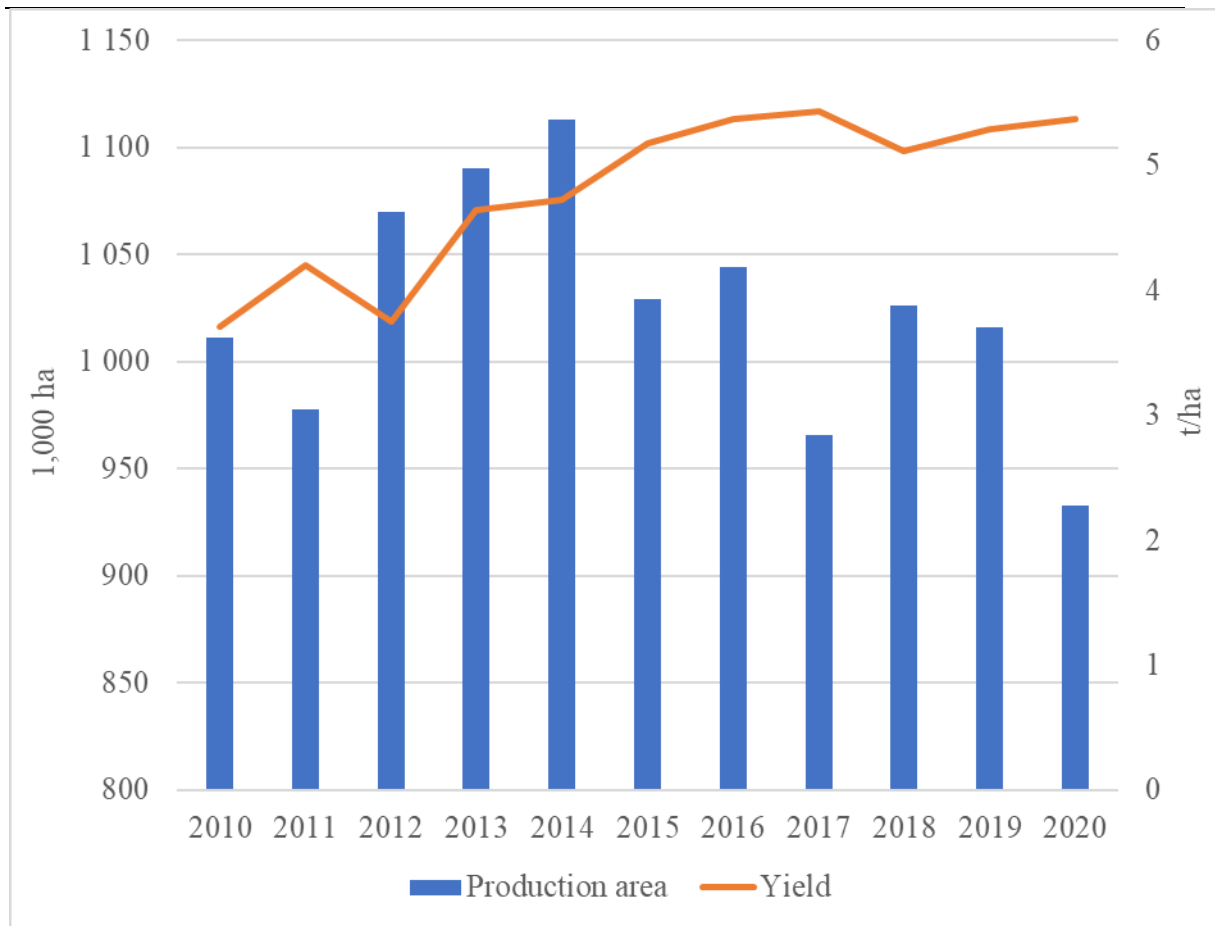


Figure 2. Area used for wheat production and average yield, 2010-2020 based on HCSO (2021a) data

Based on the figure, the strong fluctuation of the harvested area can be seen during the study period, with the two extremes being 933 thousand hectares (2020) and 1,113 thousand hectares (2014), resulting in an average value of 1025 thousand hectares in the whole period. This is fundamentally determined by the characteristics of the production technology being used (mainly the crop rotation) in addition to the expected and actual market conditions. To put this value in a broader context, it can be seen that the area used for wheat production purposes occupies 22-26% of Hungarian arable land used for cereals production, which proportion is the same as that of maize.

The other crucial component of production is yield, which has increased significantly, by almost 45% over the last 11 years. One of the most significant factors in its development is the weather condition. When this was not favorable, a substantial production decrease occurred. Figure 2 clearly shows how the – typically substantial – upward trend is broken by the year 2012 when there was both drought and record warm weather. However, it is worth highlighting that even the result of 3.75 t/ha at that time was higher than the 3.71 t/ha value recorded in 2010. BOGNÁR ET AL. (2017) improved a wheat yield forecast method that reached high accuracy in Hungary, however, handling unexpected stress events remained a significant challenge. The best result of the analyzed period was 5.43 t/ha, recorded in 2017, which can certainly be surpassed in the near future by using more

efficient seeds and modern technology (such as precision farming). PINKE ET AL. (2020) analyzed the impacts of groundwater levels on wheat and maize. Based on their results, lower groundwater levels did not significantly affect wheat yields, while they resulted in 18-38% maize yield variability. Furthermore, the important role of fertilization, which is appropriate for the given soil conditions and for the needs of wheat also plays an important role. In terms of active ingredients, this means that for every tonne of wheat produced, 25-29 kg of nitrogen, 12-15 kg of phosphorus and 18-22 kg of potassium are required, which is 5.43 times of these values for the 2017 harvest (PÁLMAI – HORVÁTH, 2016). PÁLMAI and HORVÁTH (2016) also highlighted that among our cultivated crops, mainly cereals, especially winter wheat, are the most sensitive to nitrogen supply.

Characteristics of the Hungarian wheat usage

Wheat can be used for many different purposes. The magnitude of the wheat stock available in each year is determined by the production, usage, and stocks accumulated in previous years. The composition of the different purposes of use is illustrated in *Figure 3*.

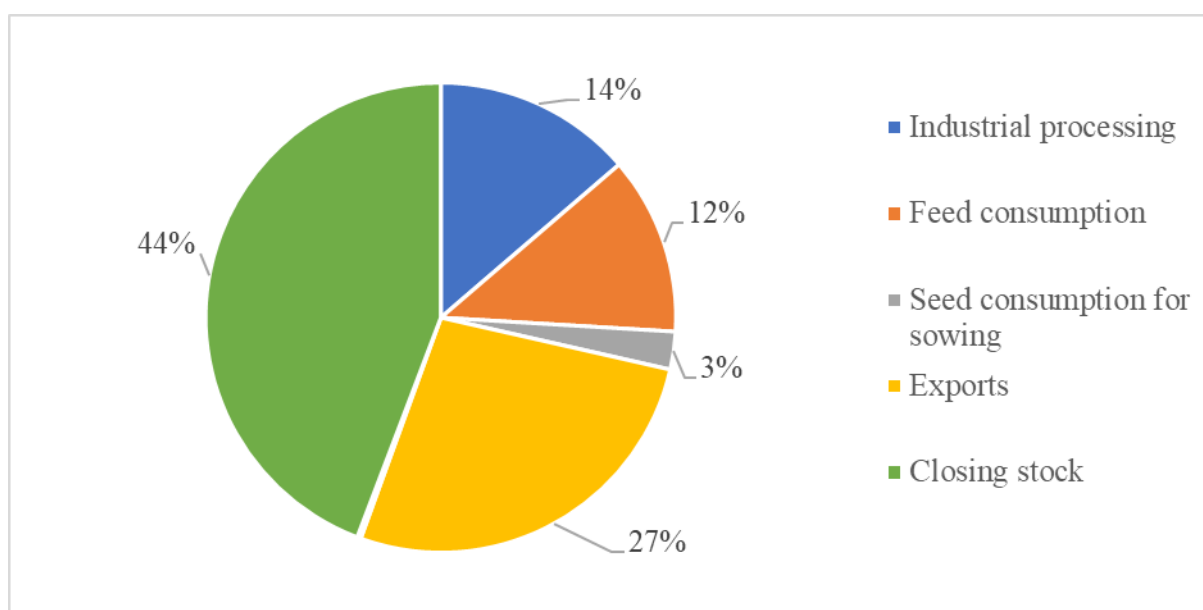


Figure 3. Purposes of wheat use, 2019 based on HCSO (2021a) data

Figure 3 shows that most of the 9.14 million tonnes of wheat used in 2019 were stored (closing stock), followed by exports (27%). Industrial and feed use accounted for 14% and 12%, respectively, while 3% was used as seeds. As the loss was only 0.26%, this item is not even shown in the figure above. 13.70% of the total amount served human nutrition directly (HCSO, 2021b).

As wheat is an important export commodity, it is also worth looking at the foreign trade performance of the sector. Table 1 shows the volume and value of exports and imports, and the trade balance, with the average price observed in each relation too.

Table 1. Cornerstones of wheat trade, 2019

	Volume (t)	Value (million HUF)	Average price (1,000 HUF/t)
Import	115,803	7,524	64.97
Export	2,467,545	151,816	61.53
Trade balance	2,351,742	144,292	

Based on HCSO (2021b) data

Table 1 shows that the export value is 2.35 million tonnes more than the import value. This means a surplus of more than 144 billion HUF. In terms of average price, there is no significant difference between exports and imports, so it is likely that there is no significant difference in their qualities.

As has already been mentioned, wheat can be used for various purposes. As a result, different varieties are grown to meet each purpose. Feed wheat lags behind milled wheat for human consumption in terms of quality, which is obviously reflected in the price of the product. Figure 4 shows the price level changes of each wheat variety during the analyzed period. Although official data of the Hungarian Central Statistical Office is not yet available for 2020, Hungarian wheat prices slightly increased in 2020, which was followed by an enormous, 30% increase in 2021 (PÁSZTOR – ECSEDINÉ WANEK, 2021).

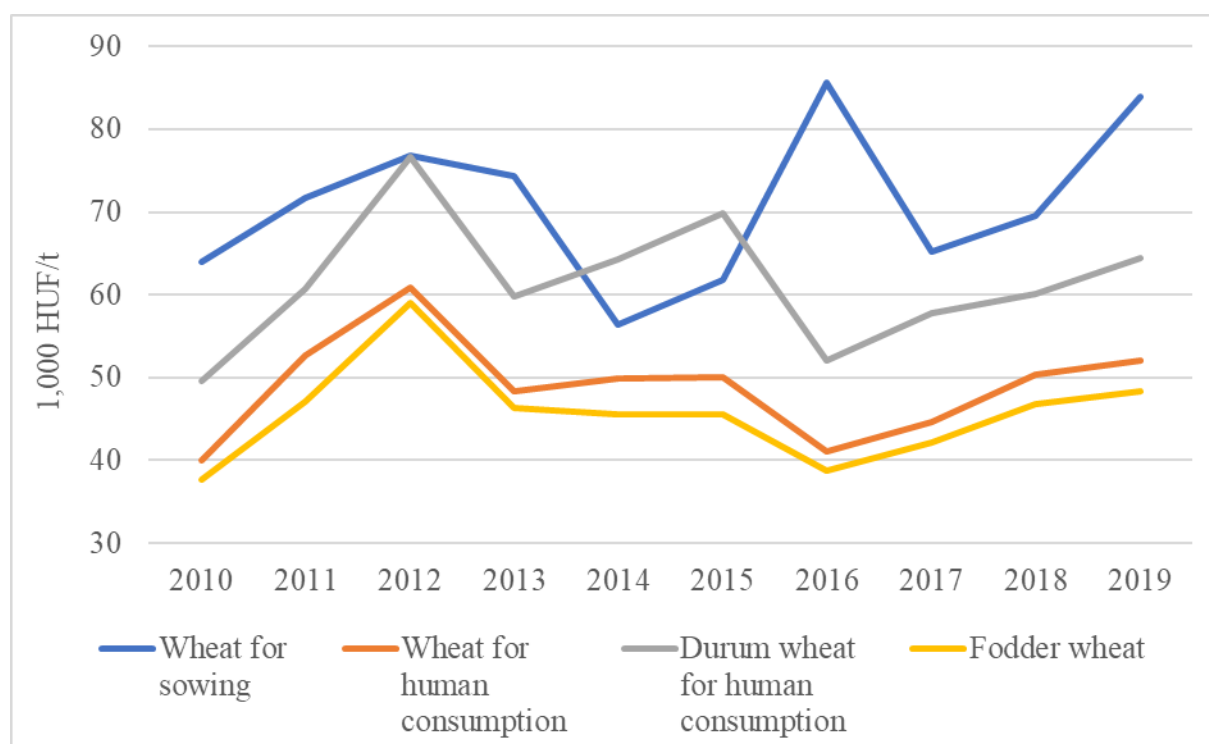


Figure 4. Price development of various wheat types, 2010-2019 based on HCSO (2021c) data

Figure 4 shows the price difference between each variety: in general, the seed is the most expensive, followed by durum wheat and wheat for food, while feed wheat is the cheapest. The difference was the highest in 2016, when the price of wheat seed was 64% higher than

that of durum wheat and 109% and 121% higher than that of food and feed wheat, respectively. Exceptions to this basic context are the years 2014 and 2015 when the price of durum wheat also exceeded that of seed. It is likely that this was due to the development of the production area, which meant a constraint on the supply side and thus resulted in a substantial increase in prices. However, the significant rise in prices triggered an adjustment in supply and the durum wheat area has expanded significantly in recent years. This is shown in *Table 2*.

Table 2. Importance of durum wheat production, 2010-2020

Year	Durum wheat production area (thousand ha)	Production area share in the total area used for wheat production purposes
2010	14	1.34%
2011	12	1.25%
2012	12	1.14%
2013	15	1.34%
2014	14	1.30%
2015	19	1.85%
2016	30	2.87%
2017	34	3.52%
2018	44	4.29%
2019	37	3.64%
2020	27	2.89%

Based on HCSO (2021a) data

The durum area has increased in recent years, but it still has never reached 5% of the total wheat area in any of the analyzed years. Although the cultivation technology is not significantly different from that of autumn or spring wheat, solvent, secure foreign markets are more important due to the higher price level. On the demand side, however, growing nutrient intolerance (especially for gluten) may be a disincentive. In general, the role of pasta in healthy diet is reduced, so it is only worthwhile to start producing durum wheat if the market opportunities are appropriate.

DISCUSSION

Wheat plays an important role in domestic crop production. This is reinforced by the fact that farmers sowed almost a quarter of the available arable land with it. In light of this, the complex management of appropriate production techniques, proper plant nutrient requirements and soil conditions are crucial, especially with regard to nitrogen use. Although a healthy lifestyle and an increase in the number of gluten-sensitive people are unfavorable for the wheat market, this is not expected to lead to a significant drop in demand for a long time, especially due to diverse use purposes (e.g. feed, ethanol or starch production). However, it should not be overlooked that wheat is a significant export item. Its export surplus exceeded HUF 144 billion in 2019. However, it should be noted that crop production, in general, is a significant beneficiary of the CAP implicating a

potentially dangerous support dependency. As the future of the CAP points to the lower and more targeted supports, Hungarian wheat producers should increase their efficiency and competitiveness if they want to maintain their current market position.

As the Hungarian market is relatively small, the profitability of production is mainly determined by world market prices. From this point of view, it is worth noting that in 2021 the market price increased by 30% compared to the same period of the previous year. There are different options available for better production performance on both supply and demand side. Regarding the supply side, creating modern seeds, adequate nutrient management or possibly irrigation would be the most promising option. On the demand side, building secure export markets would be the most important. This is exponentially true for higher-priced durum wheat, which, however, typically has only 3-4% of the total wheat area.

The increase in domestic demand would have a positive effect on the security and profitability of the production, as well as reducing the otherwise relatively high unit cost of transport. The production and export of higher value-added products, such as flour and various durable foods, should be a primary objective of the agricultural policy. By strengthening the wheat-based processing industry, a much greater added value could be produced, which can allow even economical transport over long geographical distances. In addition, all this would have a positive employment effect.

ACKNOWLEDGEMENTS

This work was supported by the National Research, Development and Innovation Office under grant number 119669, “Competitiveness of Agriculture in International Trade: A Global Perspective” and the research support program of the Institute for the Development of Enterprises at Corvinus University of Budapest. The authors gratefully acknowledge the support.

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**THE SIGNIFICANCE OF THE HUNGARIAN MAIZE PRODUCTION IN
RELATION TO THE COMMON AGRICULTURAL POLICY****TAMÁS MIZIK¹, ZOLTÁN MÁTÉ RÁDAI¹**

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*Corresponding author: tamas.mizik@uni-corvinus.hu**ABSTRACT**

Maize is one of the major crops of Hungary. This can be used in various ways, most notably for human consumption, feeding purpose, and ethanol production that is used as a fuel additive. The major indicator of its market competitiveness is the maize yield which varied over the years. This was mostly caused by the weather conditions. The use of more resistant maize varieties, as well as the proper amount of fertilizer (especially nitrogen and potassium as active ingredients), would help to stabilize yields. On the sales side, the price determines the efficiency of production. The Common Agricultural Policy plays a key role in this regard as direct payments contributed to the gross revenue of the crop producers by 57.2% on average in Hungary. The article aims to provide a detailed overview of these issues from 2010 to 2020. Based on our results, we formulated policy recommendations. Regarding maize trade, processing and, therefore, a higher share of value-added products would be essential (canned products, gluten, corn germ oil, gluten) on the export side. This would further increase Hungary's agri-food trade surplus as well as create new jobs in this sector. However, the exceptional (roughly 47%) price increase in 2021 may not be motivating enough for the different market players in the supply chain.

Keywords: maize production, international trade, common agricultural policy

INTRODUCTION

Feeding the world is one of the greatest challenges of humanity. The population is expected to reach 10 billion by 2050 (FAO, 2017). Hungary has great production opportunities and maize is one of the two major agricultural crops. Therefore, it is important to analyze its main characteristics. Due to the land abundance and favorable weather conditions, production greatly surpasses consumption resulting in a significant trade surplus. However, the sector is vulnerable to extreme weather conditions, e.g. droughts and heatwaves.

It should be highlighted that the different EU supports are extremely important in Hungarian agriculture. Direct payments of the Common Agricultural Policy (CAP) contributed to the gross revenue of the crop producers by 57.2% on average (KESZTHELYI – KIS CSATÁRI, 2020). This motivates farmers to produce crops like maize. However, this is a clear indicator of support dependency and suggests serious competitiveness problems of the cereals sector too.

Maize traditionally has been and is still an important product of the Hungarian agriculture. The maize markets show a notable surplus and there is always a satisfactory demand for this product in the different markets. It should be noted that its unit value is low, therefore, it is not profitable to be transported to long distances without transforming maize into higher value-added products.

The aim of this paper is to give an overview of the Hungarian maize production, describe the characteristics of Hungarian maize use and summarize our results and provide concluding remarks.

Characteristics of the Hungarian maize production

Maize is one of the most important crops in Hungary and its role within cereals is also significant. It is further supported by its significant share in the utilized agricultural area (UAA), which is shown in *Figure 1*. Based on this, it can be said that wheat and maize production areas were almost the same in 2020, so by far, these two are the most significant arable crops. The share of sunflower is roughly half (14%) compared to the two above, while rapeseed and various fodder crops are included in the other category.

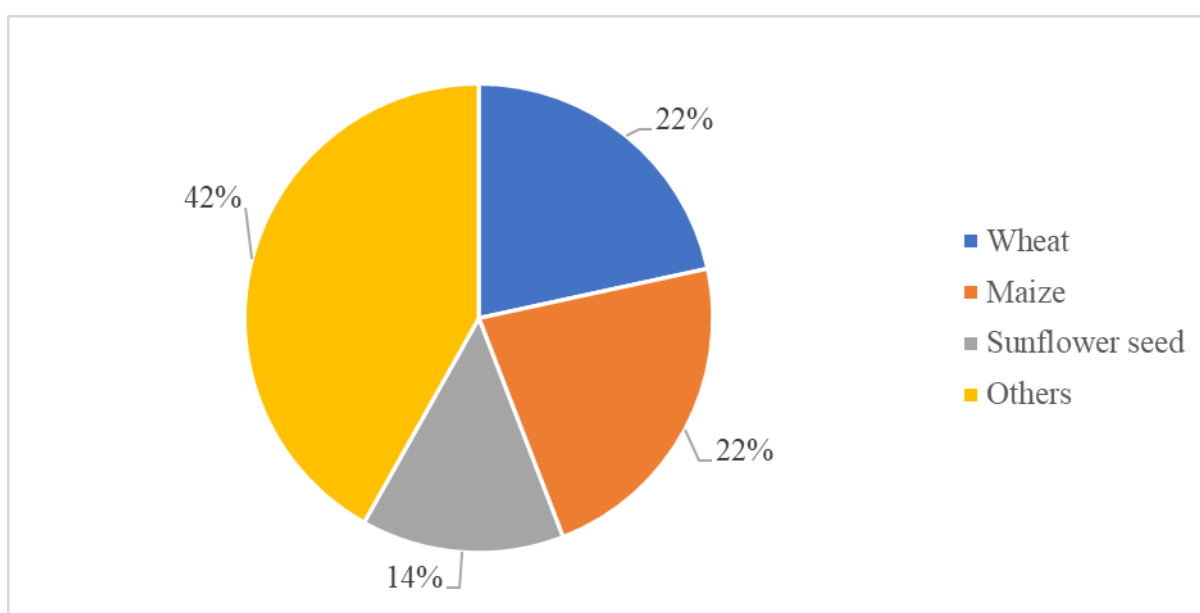


Figure 1. The major Hungarian crops by UAA, 2020 based on HCSO (2021a) and HCSO (2019) data

The important role of maize in terms of both supply and demand can be justified by several factors. On the supply side, it is worth highlighting, for example, that the Hungarian arable land is excellent for cultivation, the weather conditions are appropriate, the expertise and significant production experience of farmers are present. On the demand side, the most important aspect is the widespread and diverse use of maize, as in addition to the food industry use (isosugar, maize mush, canned maize, etc.), feed maize is an important raw material in livestock breeding, and the industrial use should also not be overlooked (ethanol and distiller's grains with solubles as a co-product). As the production level significantly exceeds the domestic market demand, maize is also an important agricultural export product as well.

The two most important indicators of production are the area used for production and the average yield. The development of these two elements is illustrated in *Figure 2* for the last 11 years (2010-2020).

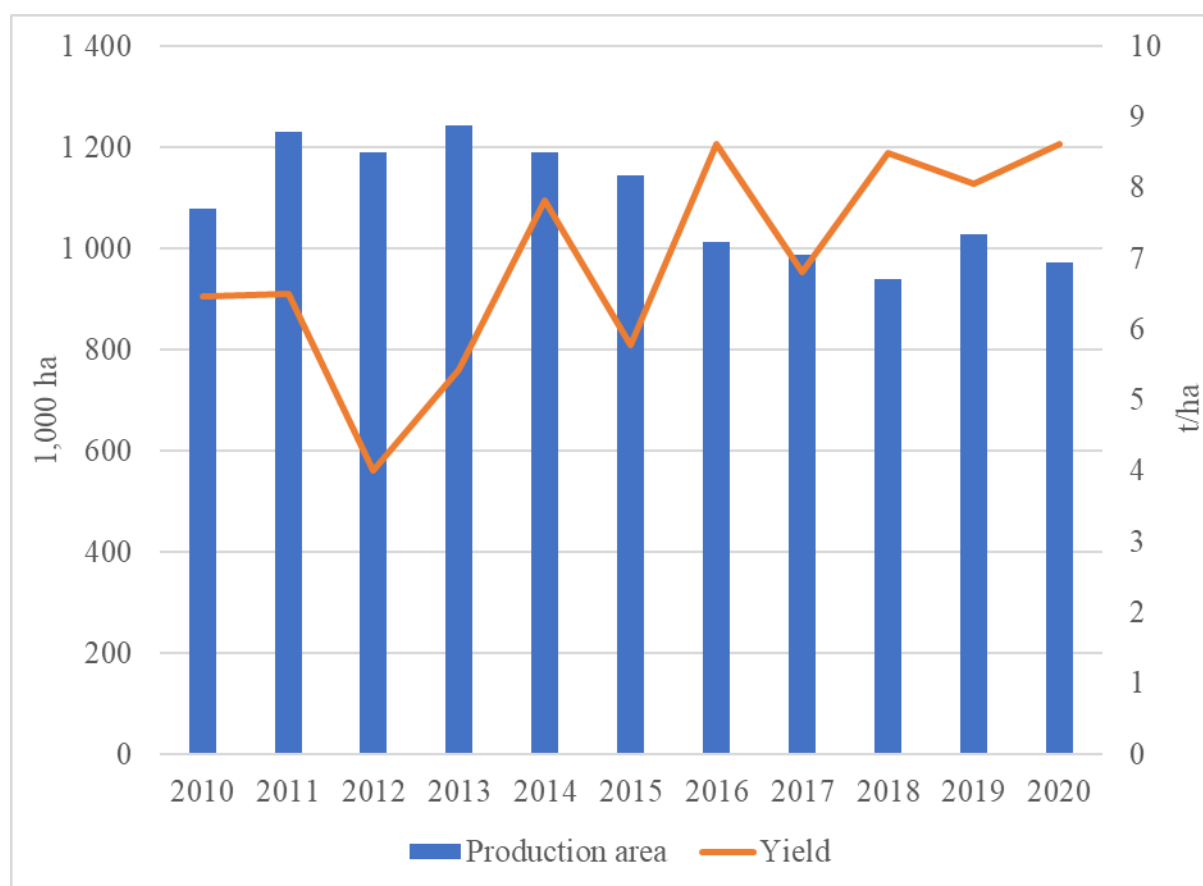


Figure 2. Area used for maize production and average yield, 2010-2020 based on HCSO (2021a) data

Based on the figure above, a steady decline of the harvested area can be seen during the analyzed period, with the two extreme values being 939 thousand hectares (2018) and 1,243 thousand hectares (2013). The average value of the 11 years is 1,093 thousand hectares. It is worth highlighting that in 2017, 2018, and 2020 the production area fell below 1 million hectares. This is fundamentally determined by the characteristics of the production technology being used (mainly the crop rotation) in addition to the expected and actual market conditions. To put this value in a broader context, it shows that the maize production area occupies 21-29% of the total Hungarian arable land used for cereals production, which proportion is the same as that of wheat.

In terms of production, the average yield is increased significantly, by 33.23% over the last 11 years (HCSO, 2021a). One of the most important contributors to this value is the weather condition, but the unfavorable circumstances, such as droughts, resulted in a significant negative change. The figure clearly shows how the – typically substantial – upward trend is broken by the year 2012 when there was both drought and record warm

weather. The 4.00 t/ha at that time did not even account for half of the 2016 record harvest (8.63 t/ha). It is likely that the use of more efficient seeds or modern technologies (such as precision farming) makes it possible to surpass even the latter in the near future. PINKE ET AL. (2020) highlighted that groundwater level is less studied; however, it is an extremely important factor. According to their results, the decrease in the groundwater can cause as much as 0.65 t/ha maize yield loss. Fertilization, in line with soil conditions and the needs of maize, also plays an important role. HOFFMAN (2018) calculated that to achieve a result of 9–10 tons yield, 120–160 kg of nitrogen, 50–70 kg of phosphorus, and 70–120 kg of potassium per hectare should be applied for grain maize. According to the author, slightly more than this is needed to achieve a result of 50–60 tons of silage corn and 20–25 tons of sweet corn. VÁNYAINÉ SZÉLES ET AL. (2012) suggested the on-site measurement of the chlorophyll content of the leaves as an adequate indicator of the nitrogen need of maize. However, management issues are as important as weather and crop yield variability for the proper forecast of maize yields (BUSSAY ET AL., 2015).

Characteristics of maize use

The use of corn is diverse, as it is suitable for food, feed, and industrial purposes. *Figure 3* illustrates the most significant purposes.

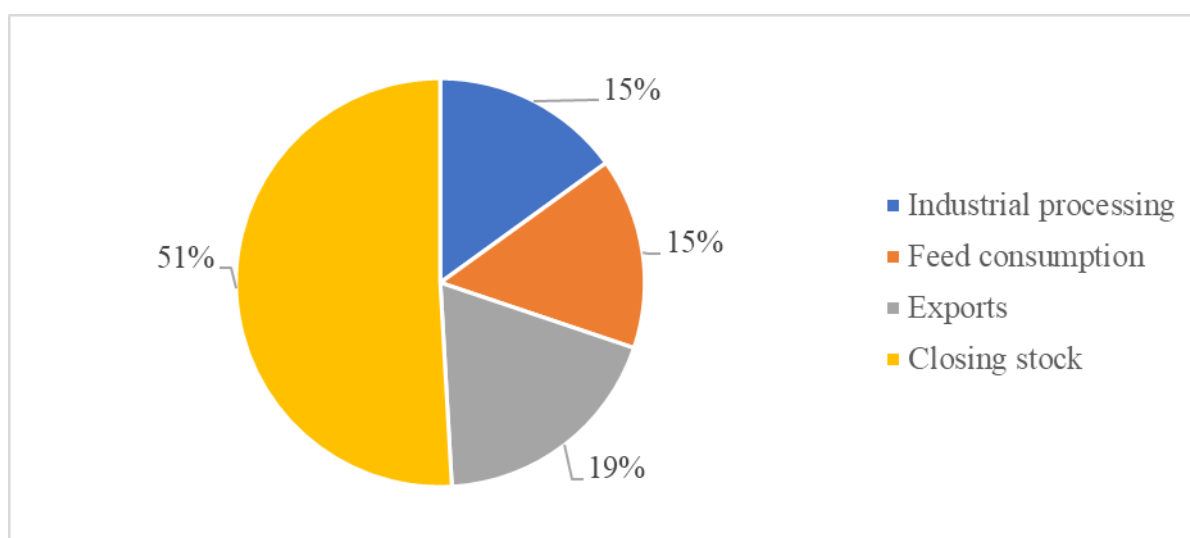


Figure 3. Purposes of maize use, 2019 based on HCSO (2021b) data

Figure 3 shows that most of the 16.87 million tons of maize used in 2019 were stored (closing stock), followed by exports. Feed and industrial use accounted for 15–15%. As the loss was only 0.42% while the seed use was 0.17%, these items are not even included in the figure above. 2.67% of the total volume served human nutrition directly (HCSO, 2021b).

As corn is an important export commodity, it is also worth looking at the sector's foreign trade performance. Table 1. shows the volume and value of exports and imports, and the overall trade balance, with the average price observed in each relation too.

Table 1. Cornerstones of maize trade, 2019

	Volume (t)	Value (million HUF)	Average price (1,000 HUF/t)
Import	204,505	41,813	204.46
Export	3,173,863	247,433	77.96
Trade balance	2,969,358	205,620	

Based on HCSO (2021b) data

Table 1 shows that maize exports are 2.97 million tons higher than imports. This difference means a trade surplus of more than 205 billion HUF. In terms of the average price, there is a significant difference between the two relations, so it is likely that the proportion of seeds in imports is significant, which is also supported by the clear substantial price difference shown in Figure 4.

Maize can be used in various ways, but the main differences can be observed in terms of feed and seed. Figure 4. shows the price evolution of them over the period considered. Official data of the Hungarian Central Statistical Office is not yet available for 2020. However, maize prices increased slightly from 2019 to 2020 followed by an enormous, 47% increment in 2021 (PÁSZTOR - ECSÉDINÉ WANEK, 2021).

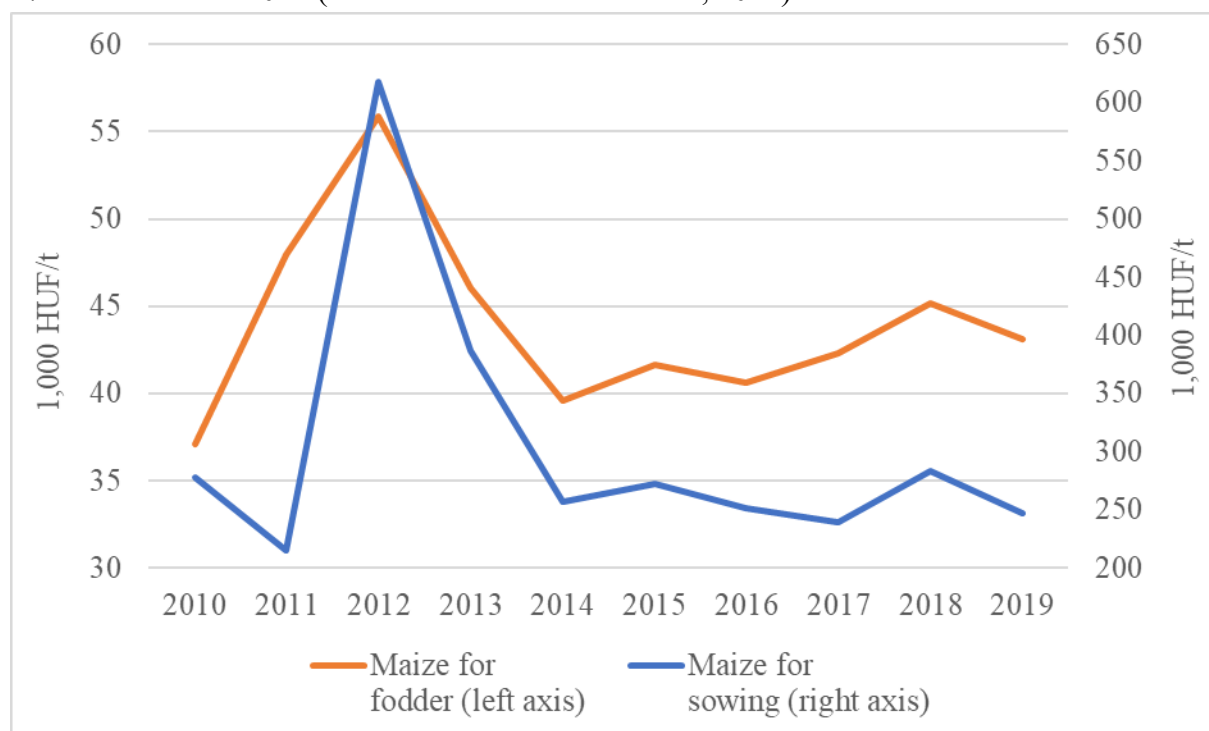


Figure 4. Price development of various maize types, 2010-2019 based on HCSO (2021c)

Figure 4. shows the significant price difference between the two varieties, the seeds are substantially more expensive than fodder maize, which is why it was necessary to use the secondary axis. The difference was the smallest in 2011 (4.48 times) and the highest in

2012 (11.07 times). The latter was due to the extremely bad weather of that year and thus to the decline in production volumes.

The supply of maize is mainly influenced by the steadily increasing average yields and weather conditions, as the production area typically fluctuates around 1 million hectares. On the demand side, the impact of several factors is worth highlighting. As the use of animal feed is significant, the contraction of the domestic livestock sector is definitely unfavorable. However, this effect is largely offset by the increasing industrial use, especially ethanol production. Although, the use of high ethanol fuels (such as E85) has dropped drastically as a result of the increase in its excise duty, the mandatory blending rate is generating stable and significant demand for maize-based ethanol. This process was further strengthened by the fact that the mandatory bioethanol blending share increased to 6.1% (GOVERNMENT DECREE 186/2019 (VII. 26.)) from 1 January 2020. However, in connection with the production, it should not be forgotten that the main by-product of dry milling technology, which provides a higher ethanol yield, is distiller's grain with solubles, which can be used mainly as feed (MIZIK ED., 2018). It is also worth to note that corn products, as opposed to wheat, can be consumed by people who are sensitive to gluten, for example.

Processing of maize provides many promising opportunities, including different final products. The price would be much higher due to the higher added value, which in the case of ethanol, for example, can be up to 75% higher than the export of maize in unprocessed form (SZÁZADVÉG, 2017). Moreover, the research of SZÁZADVÉG (2017) also revealed that even this relatively high value can be further increased by applying further innovations in production technology and management. This applies to other maize-based products, such as gluten, corn germ oil, isosugar or simply canned products.

DISCUSSION

The role of maize is outstanding in Hungarian crop production, as supported by the fact that farmers sowed this in almost a quarter of the available arable land. In light of this, it is important to apply proper management techniques. Moreover, the complex management of the plant's nutrient requirements and soil conditions are essential, which must consider the targeted average yield. In general, arable crop production is a major beneficiary of the CAP implicating a significant support dependency. As the future of the CAP points to the lower and more targeted supports, Hungarian maize producers should increase their production efficiency and competitiveness if they want to maintain their market position. Demand is diverse (food, feed, and industrial use), with the latter growing steadily, mainly due to the use of biofuels. However, it should not be overlooked that maize is a significant export commodity, the export surplus exceeded 205 billion HUF in 2019.

As the Hungarian market is small both in terms of demand and supply, the profitability of production is basically determined by world market prices. In this respect, it is worth noting that in 2021, the market price increased by 47% compared to the same period of the previous year. On the supply side, production can be further enhanced, for example, by the

creation of modern seeds, adequate nutrient management or possibly irrigation, which would have an impact by reducing unit costs of production. On the demand side, the most significant factor is the growing demand for ethanol, which has further increased through the increased mandatory blending rate from 1st January 2020. This has a direct impact on the maize market because only this raw material is used in domestic, industrial-scale ethanol production.

Exports typically include raw materials with lower unit prices, while imports include higher value seeds, which can be clearly seen from the significant difference between average export and import prices. With regard to the high production surplus, it would therefore be important to further increase domestic demand, which would not only have a positive effect on the security and profitability of production but could also reduce the otherwise relatively high unit cost of transport. The most important element of this could be the further strengthening of the processing industry leading to a much higher added value, which would allow more economic transports even over longer geographical distances. Besides, new products can be produced and marketed. All this would further increase the sector's foreign trade surplus and create new jobs.

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This work was supported by the National Research, Development and Innovation Office under grant number 119669, “Competitiveness of Agriculture in International Trade: A Global Perspective” and the research support program of the Institute for the Development of Enterprises at Corvinus University of Budapest. The authors gratefully acknowledge the support.

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EFFECT OF NITROGEN DEFICIENCY AND *FUSARIUM GRAMINEARUM* INFECTION ON RELATIVE CHLOROPHYLL CONTENT OF MAIZE SEEDLINGS

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ABSTRACT

Nowadays the global climate change significantly affects the agricultural production due to different biotic and abiotic stresses. Phytopathogens, like fusarium, can cause serious injury which could be worsened by climatic conditions. The goal of our experiment was to examine the single and the combined effect of nitrogen (N) deprivation and *Fusarium graminearum* infection on the physiology of some maize genotypes. Furthermore, we would like to know the impact of the mentioned factors on the rate of nitrogen remobilization and relative chlorophyll content (SPAD value) of leaves with different ages. Controlled pot experiment was set up in a climate room, maize (*Zea mays* L.) genotypes were grown using hydroponic conditions. Inoculation of *Fusarium graminearum* conidia was performed as a biotic stress at 5-leaf (V5) stage of the seedlings and two N level were used during the experiment: optimal N and a quarter of it from the beginning. Our results suggest that N deprivation influenced the SPAD values regardless of the age of leaves and genotype. Strong interaction was found between infection and N level in case of the younger leaves. In these leaves the relative chlorophyll content was significantly decreased due to inoculation, but just at optimal N level.

Keywords: SPAD, Maize, *Fusarium graminearum*, Nitrogen

INTRODUCTION

The condition of stalk plays a really important role in the development of maize plants. The damage of stalk tissues ultimately led to decay or at least yield loss. The disease called ‘maize stalk rot’ is caused by several group of pathogens, but the most important species are *Fusarium graminearum*, *Fusarium culmorum* and *Fusarium verticillioides* in Europe (SCAUFLAIRE ET AL., 2011). According to SINGH ET AL. (2012) the symptoms of fusarium stalk rot appears after anthesis in maize, but *Fusarium* species are able to infect any part of the maize plant at any stage of development from germination to maturity (SZŐKE ET AL., 2013). BORDERS ET AL. (2007) emphasized in their study that *F. graminearum* is the most prevalent pathogen of corn seeds and seedlings. Huge differences exist among resistance levels of genotypes to fusarium stalk rot (SZŐKE ET AL., 2009; SZŐKE ET AL., 2007). BATA ET AL. (2001) found a correlation between vegetation period of maize hybrids and the level of resistance. Based on his results hybrids with longer vegetation period had lower resistance level. The interaction between plants and pathogens is complex; moreover, it can be influenced by multiple environmental factors such as temperature, humidity, light and nutrients. Among nutrients, nitrogen assimilation is related to several crucial physiological processes, so it is unsurprising that N supply of plants can influence plant resistance to several stresses, including biotic factors as well. HOFER ET AL. (2016) highlighted that fusarium infection in spring barley is influenced by nitrogen fertilization. MUHAMMED ET

AL. (2010) found positive correlation between increasing the level of nitrogen and the injury level by fusarium in barley. In contrast, WHITE ET AL. (1978) claimed that the increased level of nitrogen resulted in a decrease in the harmful effects of fusarium stalk rot in maize. BAURIEGEL ET AL. (2011) claimed Fusarium infestation cannot be detected by spectral analysis immediately after infection in wheat plants. The goal of our experiment was to examine the single and combined effects of nitrogen deprivation and *Fusarium graminearum* infection in maize genotypes. Furthermore, we would like to know the impact of the mentioned factors on nitrogen remobilization and relative chlorophyll content (SPAD value).

MATERIALS AND METHODS

Our experimental plant was maize (*Zea mays* L.), two genotypes with different maturity were used (Armagnac FAO 490, P9903 FAO 390). Our experiment was controlled, plants were grown under hydroponic conditions, using the following nutrient solution: 2.0 mM $\text{Ca}(\text{NO}_3)_2 \cdot 4\text{H}_2\text{O}$; 0.7 mM K_2SO_4 ; 0.5 mM $\text{MgSO}_4 \cdot 7\text{H}_2\text{O}$; 0.1 mM KH_2PO_4 ; 0.1 mM KCl ; 0.5 μM $\text{MnSO}_4 \cdot 4\text{H}_2\text{O}$; 0.5 μM $\text{ZnSO}_4 \cdot 7\text{H}_2\text{O}$; 0.2 μM $\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$; and 0.1 μM H_3BO_3 . Iron was added in as 10^{-4} M Fe-EDTA. For the nitrogen (N) treatment, N content of the original solution was reduced to quarter (1/4N). Plants were inoculated with 30 μl *Fusarium graminearum* conidia suspension at the junction of the shoot and the root with injection (infected). To avoid misleading results, damage treatment was also used as a control as well (wounded). In these pots plants were wounded by a different needle which has same diameter as the needle used during infection. In addition to infected and wounded treatments, absolute control treatment was also used (control). Injection of conidia suspension was performed in the 17th day of experiment. The relative chlorophyll contents (SPAD values) were recorded on the older (3rd) and the younger (5th) fully developed leaves with SPAD-502 (Minolta, Japan). Five measurements were performed on the middle region of each leaf, the average of these values was considered as one repetition. For characterising nitrogen remobilization ability of genotypes the nitrogen remobilization rate (NRR) was used (Nagy, 2017). For the calculation of difference between the SPAD values of oldest and youngest leaf (DSI) and normalized difference SPAD index (NDSI) the equations of Lin et al. (2010) were used. The SPAD ratio of the oldest and the youngest leaf (RSI) was calculated by the equation of Shen et al. (2002), while for the calculation of SPAD relative positional difference index between the oldest and the youngest leaf (RDSI) the equation of Wang et al. (2002) was used. We made modifications on the equations of the mentioned authors. In the original indices, 1st leaf was considered as oldest leaf and the 3rd leaf was the youngest. In our calculation the following equations were used:

$$\text{NRR} = 1 - (\text{SPAD}_i - \text{SPAD}_f) / \text{SPAD}_i$$

$$\text{DSI} = \text{SPAD}_i - \text{SPAD}_f$$

$$\text{RSI} = \text{SPAD}_i / \text{SPAD}_f$$

$$\text{RDSI} = (\text{SPAD}_i - \text{SPAD}_f) / \text{SPAD}_f$$

$$\text{NDSI} = (\text{SPAD}_i - \text{SPAD}_f) / (\text{SPAD}_i + \text{SPAD}_f)$$

Where SPAD_i is the relative chlorophyll content of the 3rd leaf and SPAD_f is the relative chlorophyll content of the 5th leaf.

For statistical analysis SigmaPlot 12 for Windows (Systat Software) was used. During the data analysis, three-way ANOVA method was used with Duncan's post hoc test.

RESULTS

Based on the results of the SPAD, data obtained from the older leaves are presented in *Figure 1*. In this case we did not find significant difference between genotypes. Furthermore, infection had no effect on this parameter. In contrast, N supply significantly affected this parameter ($P \leq 0.001$). At optimal N level, remarkable higher (47.86%) SPAD values (41.87 ± 1.07) were found compared to reduced level of N (21.83 ± 0.87). We did not find any interaction between the effects of treatments.

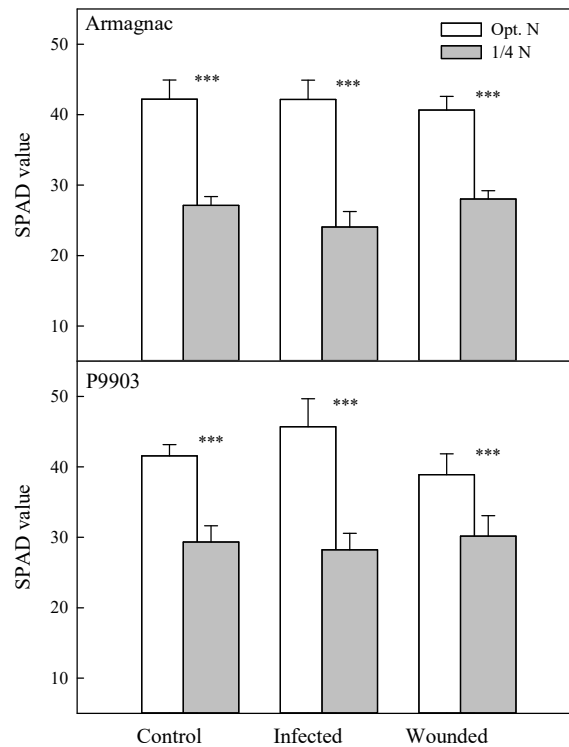


Figure 1. Changes of relative chlorophyll content (SPAD value) in the older leaves of maize hybrids (Armagnac, P9903) under different N supply (Opt. N, $\frac{1}{4}$ N) and due to infection with *Fusarium graminearum* (Control, Infected, Wounded) $n=3$, \pm s.e. Significant differences were signed ***($p \leq 0.001$)

In case of younger leaves significant differences were found (*Figure 2*) between the mean values of N levels regardless of other factors. In optimal level of N (39.14 ± 1.25) significantly higher values were observed than in $\frac{1}{4}$ N (27.07 ± 0.88). Comparison of genotypes showed significant difference. In P9903 genotype, higher (10.23 %) SPAD values (34.89 ± 1.84) were recorded than in Armagnac genotype (31.32 ± 1.69). Significant interaction was found between N and fusarium treatments ($P=0.023$). The effect of fusarium infection was observed at optimal N level. Surprisingly, significantly higher SPAD value was recorded in the infected (33.43 ± 2.88) treatment than in control (32.33 ± 1.47). However, no differences were found between infected and wounded or between control and wounded treatments. On the other hand, differences between N levels were significantly increased in infected and injured treatments. In each case, higher values were observed at optimal level of N. Difference was 16.92 (40.40%) in case of infected plants, 11.9 (30.13%) in case of wounded plants and 7.4 (20.54%) in case of control plants.

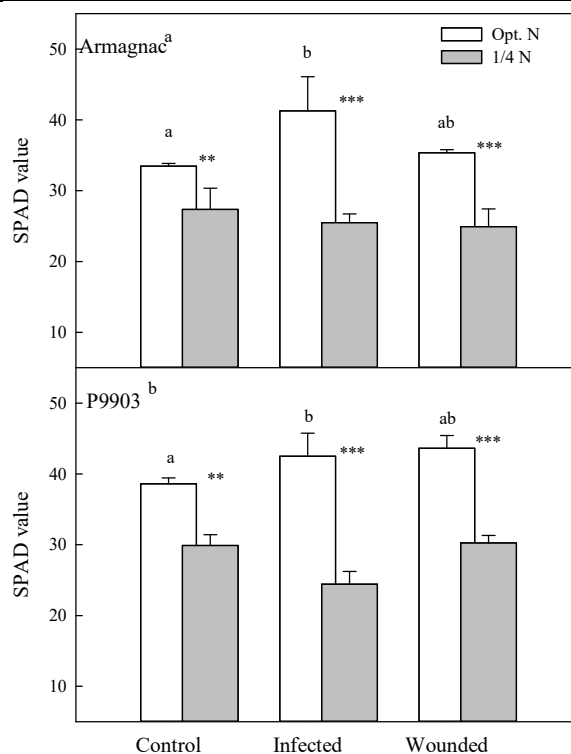


Figure 2. Changes of relative chlorophyll content (SPAD value) in the younger leaves of maize hybrids (Armagnac, P9903) under different N supply (Opt. N, 1/4 N) and due to infection with *Fusarium graminearum* (Control, Infected, Wounded) $n=3$, \pm s.e. Significant differences were signed with letters (a, b, c) ($p \leq 0.05$) and ***($p \leq 0.001$)

Indexes calculated from SPAD values are presented in *Table 1*. Our treatments had no significant effects on these parameters. The values of Nitrogen Remobilisation Rate showed higher values in case of reduced N level and Armagnac hybrid. Concerning the difference between the SPAD values of oldest and youngest leaf, the highest difference was found in case of optimal N level in Armagnac genotype (8.73 ± 5.3). In case of SPAD ratio between the oldest and the youngest leaf, we found similar results. We didn't find any outlier value which can be highlighted in case of RDSI and NDSI.

Table 1. Changes of the Nitrogen Remobilisation Rate (NRR), difference between the SPAD values of oldest and youngest leaf (DSI), SPAD ratio of the oldest and the youngest leaf (RSI), positional difference index between the oldest and the youngest leaf (RDSI), normalized difference SPAD index (NDSI) values by the effect of maize hybrids (Armagnac, P9903), different N supply (Opt. N, 1/4 N) and infection with *Fusarium graminearum* (Control, Infected, Wounded) $n=3$, \pm s.e.

			NRR	DSI	RSI	RDSI	NDSI
Armagnac	opt. N	Control	0.8 ± 0.1	8.73 ± 5.3	1.26 ± 0.16	0.26 ± 0.16	0.11 ± 0.06
		Infected	0.98 ± 0.13	0.9 ± 5.87	1.04 ± 0.13	0.04 ± 0.13	0.02 ± 0.07
		Wounded	0.87 ± 0.05	5.3 ± 2.66	1.15 ± 0.07	0.15 ± 0.07	0.07 ± 0.03
	1/4 N	Control	1.02 ± 0.24	-0.23 ± 6.53	1.02 ± 0.23	0.02 ± 0.23	0.0004 ± 0.12
		Infected	1.08 ± 0.21	-1.43 ± 5.23	0.95 ± 0.21	-0.05 ± 0.21	-0.03 ± 0.11
		Wounded	0.89 ± 0.17	3.1 ± 5.01	1.15 ± 0.25	0.15 ± 0.25	0.06 ± 0.1
P9903	opt. N	Control	0.93 ± 0.03	2.97 ± 1.33	1.08 ± 0.03	0.08 ± 0.03	0.04 ± 0.01
		Infected	0.93 ± 0.04	3.2 ± 2.39	1.07 ± 0.05	0.07 ± 0.05	0.04 ± 0.02
		Wounded	1.14 ± 0.25	-4.73 ± 8.25	0.90 ± 0.18	-0.1 ± 0.18	-0.06 ± 0.1

		NRR	DSI	RSI	RDSI	NDSI
1/4 N	Control	1.02±0.05	-0.57±1.54	0.98±0.05	-0.02±0.05	-0.01±0.03
	Infected	0.88±0.2	3.8±5.77	1.17±0.24	0.17±0.24	0.07±0.11
	Wounded	1.02±0.17	-0.10±5	1.00±0.16	0.002±0.16	-0.01±0.08

DISCUSSION

Around ten fusarium species toxic for maize, *Fusarium graminearum* is one of the dominant *Fusarium* species in Hungary (MESTERHÁZY ET AL. 2011; 2019). The application of non-destructive measurements to detect early non-visible symptoms of fusarium is contested, mainly during the early growth stages, but suitability of SPAD meter to characterization of *in vivo* N status was proven by a lot of studies (XIONG ET AL., 2015; YANG ET AL., 2014; SIMKÓ ET AL., 2018). BANDARA ET AL. (2016) found that SPAD value was suitable to detect symptoms of infection in sorghum (*Sorghum bicolor* L.). In the present study we found interaction between the effects of N supply and fusarium infection. Nitrogen deprivation significantly influenced SPAD value, but the level of impact depended on the infection treatments. We didn't find any differences between genotypes susceptibility to fusarium infection. Although our results confirmed that the SPAD value is appropriate for detecting N status, yet indexes from SPAD values were not reliable in detecting N status, fusarium infection or differences between genotypes in case of maize.

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MEAT QUALITY PARAMETERS AT DOMESTIC TURKEYS FED VARIOUS DIETARY RATIONS

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ABSTRACT

In relation to other poultry species, turkeys belong to the largest poultry and the best producers of high-quality poultry meat, because it contains a high percentage of protein, especially essential amino acids and low fat content. Turkeys used for this study were originated from the domestic breed of turkey (white and black). A total of 30 turkeys were grown under the so-called indoor keeping system in Pelagonia region, North Macedonia. The aim of the research was to determine the differences in the body weight in the period of 10 - 90 days and the slaughtering characteristics of turkeys fed with two different rations in relation to the origin of feed proteins (group R - fed with fish flour and group S - fed with whey powder). An analysis of the chemical composition of the large breast muscle (Musculus pectoralis superficialis -MPS) was also performed on samples of the two groups of turkeys. Statistics (ANOVA) on turkey growth (10-90 days) show significant differences in body mass between the two groups of S and R for different feeding intervals. The results of the examinations of the chemical composition of the MPS showed higher values for protein and fat in the meat of turkeys fed with whey powder and were (protein 25% and fat 8.67%) compared to the values of turkeys fed with fish flour and were 23.27 and 6.5% respectively. At the same time, protein and fat values were significantly different among the groups.

Keywords: Domestic Turkey, fish flour, whey powder, turkey's breast muscle.

INTRODUCTION

Generally, turkey breeding is due to the production of high quality meat, rich in protein (30-34%) and essential amino acids.. In this context, it is compulsory to note that the amount of nutrients, as well as the quality of poultry fat depends primarily on the genetic potential of poultry, and then on the way it is raised and fed (LOFGREN ET AL, 2005). In addition, for intensive growth of juvenile turkeys, foods containing an adequate amount of protein and a balanced composition of amino acids are preferred (DZERMANOVIC ET AL, 2007). That is why, in order to meet the dietary requirements of turkeys and to achieve intensive fattening, the feed industry processes by-products of animal origin, including fish meal and whey proteins, which contain a significant percentage of protein. In the first month of breeding, the required content for the total protein in the turkey food is 28%, while from the next month it decreases by 2% (BAKER, 2000).

MATERIALS AND METHODS

The research was conducted over a four months period, in a small poultry farm in the Pelagonija region. The subject of analysis of the research were 30 juvenile turkeys (black and white breed) hatched from eggs raised in an incubator. During the study, turkey juveniles were bred in a closed system with temperature control (T = 18-22 °C), light (13 h

lighting) and ventilation. The diet was provided ad libidum. For the first 21 days, the throats were fed with a turkey starter. While, on the 22nd day, they were divided into two groups of 15 turkeys, respectively, based on the different concept of nutrition. That is, group I turkeys fed a mixture containing fishmeal (R-group) and group II turkeys fed a mixture containing whey powder (group S). The composition of fish meal added to the feed mixture of R-group turkeys was as follows: lysine 28,000 mg, methionine 12,000 mg, CaCO₃ = 2,000 mg, NaCl = 4,000 mg, acidifier 2000 mg, aroma 2000 mg, carrier 2000 mg, soy protein isolate, peeled soybean meal flour, amino acids and antitoxin. Meanwhile, whey powder added to the feed mixture of S-group was composed of 80% whey protein (cow, sheep and goat), 11.9 g carbohydrates and low saturated fat content (11.9 g out of a total of 3, 4 g / 100 g whey powder). Additionally, the standardization of the content of the components in the different mixtures for the turkeys was performed according to the age in weeks (*Table 1*).

Table 1. Composition of feed mixture for turkeys from 0-14 weeks of age (modified by Petrovic, 1988)

Fodder mixture for juvenile turkeys	0 – 4 weeks	4 – 8 weeks	8 – 10 weeks	10 – 14 weeks
Maize	44 %	50%	54%	57%
Soy	34%	34%	26%	21%
Wheat	3%	5%	7%	7%
Sunflower husk	2%	3%	4%	4%
Fish flour / Whey powder	10 %	6%	3%	2%
Fodder yeast	2%	1%	1%	1%
Pork fat	2%	3%	4,5%	4,5%
Livestock chalk	0,5%	0,5%	0,5%	0,5%
Sol	0,2%	0,3%	0,3%	0,3%
Minerals	1%	1%	1%	1%

Live Body weight was measured every 10 days during turkey rearing. At the end of the experiment (day 100), turkeys were slaughtered manually in a specialized workshop for slaughtering domestic animals and birds near the breeding facility. The birds were slaughtered after 12 hours of starvation by physical stunning. Additionally, after slaughtering, at 14 turkeys (7 from R-group and 7 from S-group) were measured pre-slaughter live weight, body mass without feathers and skin, mass of processed carcass, mass of edible parts and parts which are not edible, as well as the yield (rendement) of the classically processed carcass. The quality of the meat was assessed according to the analysis of six (6) samples of large pectoralis major muscle (*Musculus pectoralis superficialis* -MPS). The samples were properly labeled, packaged and transported at the temperature ($t = -10^{\circ}\text{C}$) to the laboratory where the chemical analyzes were performed. Chemical analyzes were conducted on a blended homogeneous sample. The percentage of protein was analyzed by the Kjeldahl method, while the percentage of fat was analyzed by the Soxhlet method. The analysis of the moisture content was done according to the reference method ISO 712/2009, while the percentage ash according to the reference

method ISO 3539/1981. The analyzes were performed the next day in duplicate. ANOVA test was used for statistical data processing. Significant differences were determined at the level of 5% significance.

RESULTS

In the *Figure 1*. are shown the results in terms of live body weight of the two groups of turkeys (R-group and S-group) in the period of 90 days. Throughout the research it was found a statistically significant relationship between the groups at the level of $p < 0.05$. Additionally, a greater body weight was measured in the R-group juvenile turkeys compared to the S-group turkey juveniles. The obtained results indicate the fact that the addition of fishmeal to the diet of the offspring gives better results (R-group). The most pronounced increase in live weight of the offspring of the S-group was observed from 80-90. day (*Figure 1*).

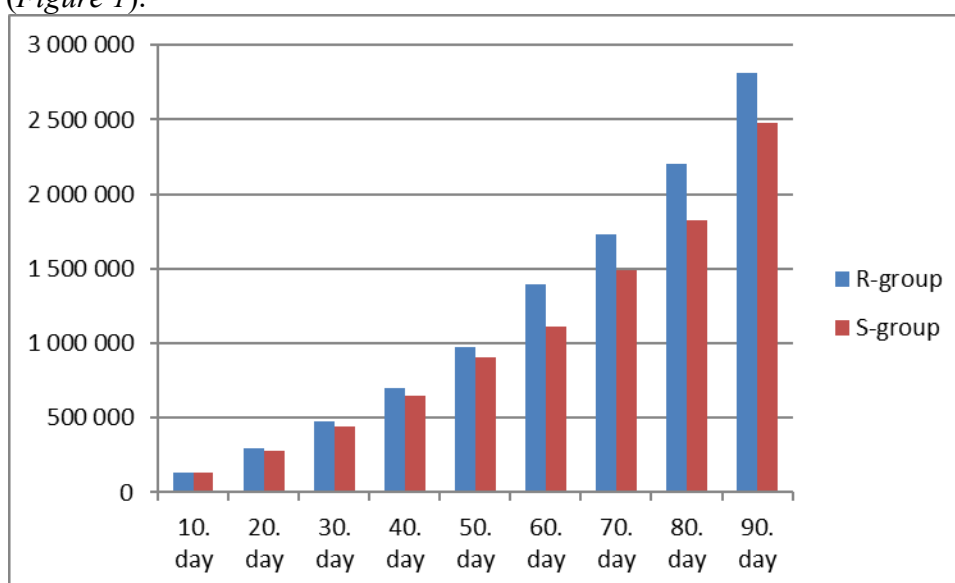


Figure 1: Measurement results of live body weight (g) of juvenile turkeys from 10th to 90th day

Table 2 show the results in terms of slaughter and carcass traits at both groups of turkeys (R-group and S-group). Thereby, there were no statistically significant differences in the parameters from the groups R and S ($p > 0.05$). Before slaughtering, a live body weight at the R and S groups is 2.78 kg and 2.43 kg, respectively. While the average body weight of the classically processed carcasses is 1.77kg and 1.52kg.

Table 2: Obtained results from the analysis of the slaughter and carcass traits

(N=8)	Group	Live weight before slaughter (kg)	Carcass mass without feathers and skin (kg)	Classically processed carcass (kg)	Edible portions (%)	Non-edible portions (%)	Meat yield (rendemen) (%)
x±SD	R	2,78±0.70	2,18±0.52	1,77±0.46	0.22±0.05	0.15±0.03	63.50
	S	2,43±0.28	1,87±0.22	1,52±0.18	0.19±0.05	0.14±0.04	62.72

In addition to meat yields, the meat industry should also pay attention to meat quality. The most important key aspect of the quality of food, as well as poultry meat, is its nutritional

value. *Table 3* shows the results obtained in terms of quality characteristics of the two groups of turkeys (R-group and S-group). It was found that the percentage of protein and fat is significant ($p < 0.05$), while there is no significant difference between the percentage of moisture and ash ($p > 0.05$).

Table 3: Obtained results from the analysis of the qualitative characteristics of the large breast muscle

(n=3)	Group	Proteins (28%)	Fat (25%)	Moisture (75%)	Ash (2%)
x	R	22.27 ^b	6.50 ^b	27.90 ^a	1.28 ^a
	S	25.00 ^a	8.67 ^a	28.83 ^a	1.19 ^a

* The differences of the values with different superscripts in the same column are statistically significant at the level: a: b, $p < 0.05$

The protein content is 22.27% and 25% in the R and S groups, respectively. The results of the examinations of the chemical composition of the breast muscle showed greater values of protein and fat in the meat of S-group turkeys, namely 25% protein and 8.67% fat, compared to the values of R-group turkeys fed with fish flour and were 23.27% or 6.5%. At the same time, protein and fat values were significantly different ($p < 0.05$) between the groups.

DISCUSSION

According to KARIMI (2006) the addition of fish flour meal to the ration of the turkey's offspring is most pronounced in the later life period (days 20-42) when it is added in concentrations of 2.5%. More detailed research on live weight gain in whey protein-fed offspring was conducted by (SZCZUREK ET AL., 2013, DZERMANOVIC ET AL., 2007). In their research, the addition of whey protein to the offspring's diet leads to an increase in live weight as well as food conversion. According to KERMANSHAHI AND RASTAMI (2006) the addition of whey protein in the diet of the offspring gives the best results of 42-49 days, the increase in live weight is by 2-4%. Additionally, they measured the increase in live body weight from 1- 42 days, but concluded that it is best to add them from 42-49 days because then the live weight begins to increase more pronounced. We noticed similar results. In this context, in the study made by AL-DABBAS ET AL. (2007), whey powder being mixed daily with the drinking water at rate 0.25, 50 and 75%, and given to poultry at 4 and 8 weeks of age. In the 25% whey treatment, the ultimate live weight of broilers increased by 2.3%, while higher whey concentrations (50 and 75%) reduced the live body weight by approximately 15 and 40%, respectively. It has been shown that nutritive additives, including whey proteins, should not be used constantly and that occasional giving has been more effective. The quality of meat depends on biological factors (genotype, sex and age), as well as on paragenetic factors - including breeding and nutrition concepts (HELLMEISTER et al, 2003, DOU ET AL, 2009). The data reported in our study were similar to those obtained by DZERMANOVIC (2007) where the average live weight of turkeys before slaughtering was 10.70 kg, while the classically processed carcass was 8.78 kg. Additionally, in our research the meat yield (rendement) was 63.50% (R-group) and 62.72% (S -group). Similar results were found by VERCEK ET AL. (2008) where the average meat yield of wild turkeys was 67.99% with an average live weight of individuals of both sexes of 3.932 kg. The lower percentage of the meat proteins at turkeys fed with fish flour was observed in the research of JASSIM (2010), where in parallel with the increase in the percentage of fishmeal in the diet of the offspring, the protein content also increased.

Moreover, when the offspring were fed with 100% fish meal, the percentage of proteins was 18.22%. In addition, the results obtained in our research are slightly higher compared to the results shown in the research of BOGOSAVLJEVIC - BOSKOVIC ET AL. (2006) where the protein content in the breast muscle varied from 22.57 to 23.72%. Regarding the percentage of fat, it was found that they are more present in the breast muscle than the S-groups (8.67%), while in the R-groups it was (6.5%). This data is in accordance with the research conducted by JASSIM (2010) who found that the fat content of meat is inversely proportional to the content of fish meal. That is, the control sample contained 12.14% fat, while with each increase of the percentage of participation in the fish meal 25%, 50%, 75% and 100%, the percentage of fat in meat decreased by 12.10%, 11.30%, 10.43% and 10.20%, respectively. Poultry nutrition not only determines the basic characteristics of the production results and nutritional values, it also significantly shapes the taste and smell of meat. However, in the diet with fish meal, especially in laying hens for eggs and broilers, as a result of the diet there is an unpleasant odor and taste of meat and eggs, specific smell and taste of fish (PIETERSE ET AL., 2014). Therefore, the diet with fish meal is limited only to young categories of animals.

According to the results of this study, it can be concluded that fish meal is a better supplement in the turkey's ration compared to whey proteins because the R-group have a higher live weight (2.809,875 kg) compared to those of the S group (2.475,250 kg). Regarding the slaughter parameters, the obtained results are almost equal ($p > 0.05$). However, as this is the first research about feeding concepts in turkey's diet in our country, at least in recent decades in poultry farming, we believe that a number of additional trials and repetitions are needed in order to reach a conclusions and give some recommendations for the practice regarding nutrition and improved meat quality.

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NATURAL *FUSARIUM* TOXIN CONTAMINATION OF WHEAT IN SOUTHERN PART OF HUNGARY

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ABSTRACT

Fusarium head blight (FHB), primarily caused by a fungal plant pathogen *Fusarium graminearum*, is a devastating disease of wheat and other cereals. FHB reduces yield, but also the quality and feeding value of the crop. The fungus produces the mycotoxin deoxynivalenol (DON) that poses a significant threat to the health of domestic animals and humans. In 2019 *Fusarium* epidemic occurred not only the southern and eastern parts of Hungary, but affected other area of Central Europe. The mycotoxin patterns varied tremendously, depending on the geographic area, different resistance levels of wheat genotypes, weather and soil conditions and cropping factors. In this survey 192 samples of different bread wheat (*Triticum aestivum* L.) genotypes from three geographically different regions were tested for DON toxin contamination by HPLC-MS method. Average levels of mycotoxin contamination 3.80 mg/kg; it is three times higher than the European maximum limit for unprocessed cereals intended for human consumption. The content range is very wide (0.15 – 20.71 mg/kg), 76% of the samples exceeded the EU risk threshold level.

Keywords: *Fusarium* head blight, DON, *Fusarium* epidemic, HPLC, toxin

INTRODUCTION

Fusarium head blight (FHB), also known as scab, is an important fungal disease of wheat, barley and other cereals (MESTERHÁZY, 1984; MOSCHINI ET AL., 2001). FHB results not only reduction in yield, but also spoils quality and usability (SAYLER, 1998; GOSHWAMI AND-KISTLER, 2004). The main causes of FHB are *F. graminearum* and *F. culmorum* in Europe, but *F. graminearum* is also the predominant species in the United States (TÓTH ET AL., 2008; DOOHAN ET AL., 1998; XU ET AL., 2005). These fungus species can produce harmful secondary metabolites, called mycotoxins, which can cause food and feed safety risk. The most important *Fusarium* mycotoxin is DON (deoxynivalenol) belongs to the type B trichothecenes family (DESJARDINS AND PROCTOR, 2007). DON and other trichothecenes (TERZI ET AL., 2014) can inhibit eukaryotic protein synthesis and can cause anorexia, diarrhea, vomiting, cell death, gastrointestinal function, immune suppression and can confuse the action of growth hormones (PESTKA, 2010). This is the reason that the EU and the countries of the world have set strict limit values for treated and untreated cereals and food (SELAMAT AND IQBAL, 2016). *Fusarium* sporulation and wheat head infection is favored by moist, warm conditions during flowering. The warming weather inhibits disease and toxin development, but there are years with moderate warm and wet flowering periods (like in 2019) supporting outbreak of heavy epidemics and toxin contamination (MORETTI ET AL., 2018). The FHB is most severe in warm and wet conditions during anthesis (MESTERHÁZY, 1995; PARRY ET AL., 1995). In 2019, weather conditions were favorable for *Fusarium* infections, in May the amount of precipitation was 134 mm, while rainfall was also in surplus through July. This significant precipitation level was the major precursor to *Fusarium* mold growth, so a strong *Fusarium* epidemic occurred in most

regions of wheat growing area of the country. In 2019, *Fusarium* infection caused enormous problems in the whole southern European region. The west Romanian and north Serbian territories showed similar picture in DON contamination (COTUNA ET AL., 2021) and this was the same on the Hungarian side of the border.

MATERIALS AND METHODS

Plant materials

Different bread wheat (*Triticum aestivum* L.) genotypes from two conventional breeding nurseries (192 samples) were tested for DON toxin contamination in 2019. Samples derived from the south part of Hungary near Szeged and Makó, the distance between the two locations is 31 km. The ninety-six tested wheat genotypes with wide genetic background were the same at both locations. Furthermore 24 wheat samples derived from Táplánszentkereszt (close to Szombathely). All the tested genotypes chose from breeding materials of the Cereal Research Non Profit Ltd. We examined four experimental block, every block contained twenty different species combination and four controls.

Toxin extraction and analysis

The samples were ground into flour using a laboratory mill Perten Laboratory Mill 3310, Perten Instruments, United Kingdom). Four ml of acetonitrile:water mixture (84:16) was weighed into centrifuge tubes to which 1-1 g flour samples were added. These were extracted on a vertical shaker (Stuart STR4 rotator, Stuart Equipment, United Kingdom) for 2.5 hours. The samples were then centrifuged at 4400 rpm for 10 min (Heraeus Megafuge 8, Thermo Fischer Scientific, United States). One ml of the supernatant was pressurized under high pressure through an alumina:activated carbon (20/1) SPE tube. 500 µl of the purified material was measured into vials and then evaporated. The residual solid was redissolved in acetonitrile:water (20:80) and the sample was homogenized by vortexing and sonication for 5 min. Subsequently, the DON toxin content of the sample was determined using an Agilent 1260 HPLC equipped with DAD instrument (Agilent, United States). A Zorbax SB-Aq (3.5 µm, 4.6 x 50 mm) HPLC column (Agilent, United States) with a ZorbaxSB-Aq (3.5 µm, 4.6 x 12.5 mm) pre-column was used to separate the sample components. Five µl of the prepared samples was injected onto the HPLC column. The flow rate was one ml/min. The column temperature was maintained at 40 °C. Detection was performed at 219 nm. All the used chemicals purchased from Sigma Aldrich Ltd. Correlation and regression analyses based on the Excel built-in functions.

RESULTS

In case of samples derived from Szeged the average DON toxin contamination was 1.84 mg/kg, this value is higher than the EU threshold level (1.25 mg/kg). From the genotypes we examined more than 55% had higher DON toxin content than the EU limit value. The content range is very wide, from 0.15 mg/kg to 8.02 mg/kg (*Figure 1.*). The controls (orange lines on the figures) had 1.44 mg/kg average DON contamination. 46% of the genotypes had lower toxin content than the average control value. Only 2% of the examined genotypes had lower DON contamination than those of the most resistant control species.

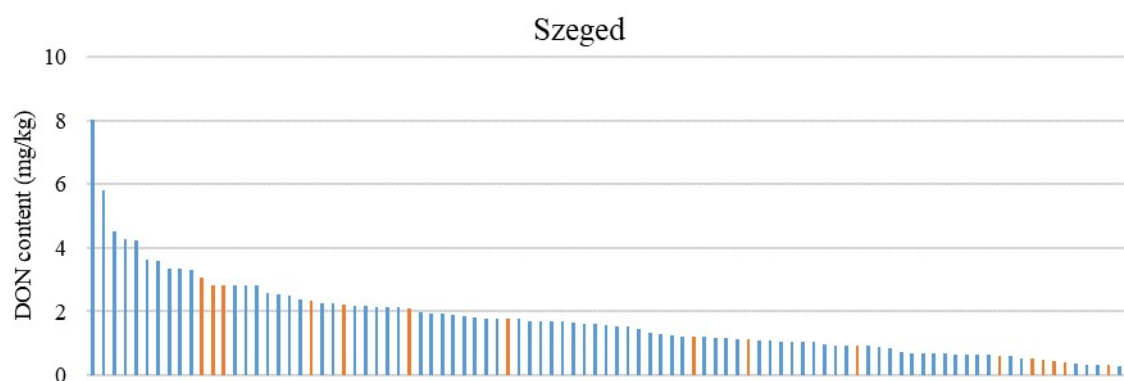


Figure 1. DON toxin contamination of different genotypes from Szeged, Csongrád-Csanád county, 2019

In Makó the DON contamination of the samples was much higher than in Szeged. The average value was 5.77 mg/kg, which is almost five times higher than the EU limit. (Figure 2.) Furthermore, in Makó only 3.13% of the examined genotypes had lower DON toxin contamination than the EU risk threshold level, and 6.25% had lower toxin content than the most resistant control. Average control contamination was 3.63 mg/kg.

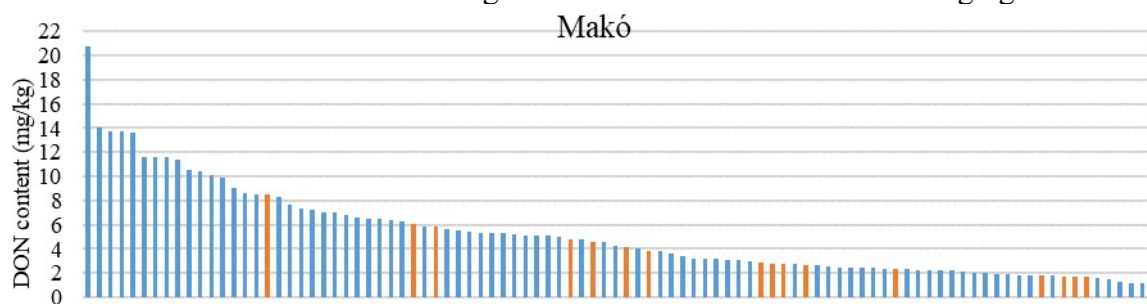


Figure 2. DON toxin contamination of different genotypes from Makó, Csongrád-Csanád county, 2019

The possible reason for the DON content differences between samples arrived from Szeged and Makó, the uneven precipitation distribution. In May the rainfall level was the same (~134 mm) in the two locations, but in June the precipitation level was 206 mm in Makó, and only the half of this value in Szeged despite of the small distance. For us the most important information was the several genotypes that were low toxin contaminated in both tests (Figure 3.). From these results, the good yielding lines will be identified and also genotypes having better quality and resistance also to other diseases like leaf rust, leaf spots, etc. It is very important that there are exploitable differences between lines not bred with FHB resistance, which can develop the portfolio of the Cereal Research Institute.

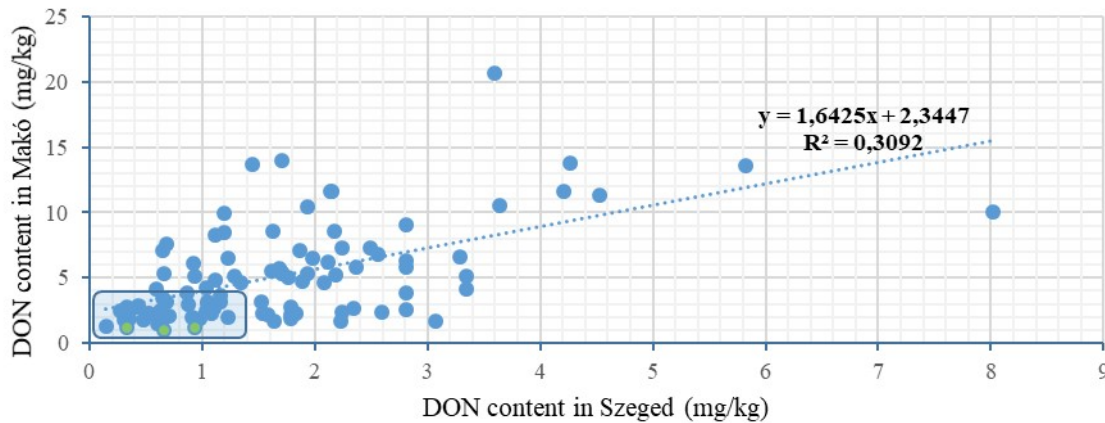


Figure 3. The correlation and regression of the DON toxin contamination in Szeged and Makó. Green spots shows the genotypes which had lower toxin contamination than the EU limit in both locations. The box shows those genotypes which had lower toxin content than the controls average contamination.

In Táplánszentkereszt, which is located in the northwest part of Hungary, the average DON content was 1.5 mg/kg, and 50% of the examined genotypes had lower toxin level than the EU limit value (*Figure 4*). 33% of the samples had lower toxin content than the most resistant control. The average toxin contamination was 1.92 mg/kg in case of the control species.



Figure 4. DON toxin contamination of different genotypes from Táplánszentkereszt, Vas county, 2019

DISCUSSION

In 2019, due to the favorable weather conditions, there was a remarkable *Fusarium* epidemic in the southern part of Hungary. The average internal *Fusarium spp.* infestation level was 22.9 for the whole country (CSERTÁN-HALÁSZ, 2019). Detailed values show that the infection level is not the same for all counties. As breeding stations of the Cereal Research Nonprofit Ltd. are in Csongrád-Csanád and Vas counties, we focused on the DON toxin content of samples derived from these regions. Based on the survey of National Food Chain Safety Office, in Csongrád-Csanád county the internal *Fusarium spp.* infestation level was 21.17%, till in Vas county, this value didn't reach the 5%. Although we can find counties close 50% values, mainly on the Great Plain.

The average DON toxin content is similar in Szeged and Táplánszentkereszt (1.84 and 1.5 mg/kg, respectively), but the internal *Fusarium* infestation levels are different in the two locations. These results confirm that we have to check the toxin contamination of the

cereal samples besides the phenotypical evaluation of the symptoms caused by *Fusarium*, because in some cases only slight correlation can be found between the two types of data. Furthermore large differences can be found between the three locations in same genotypes (Figure 5.). On the one hand the different weather conditions can explain the distinct toxin values. The different ecological and agro-technical factors indirectly also can influence the infection levels.

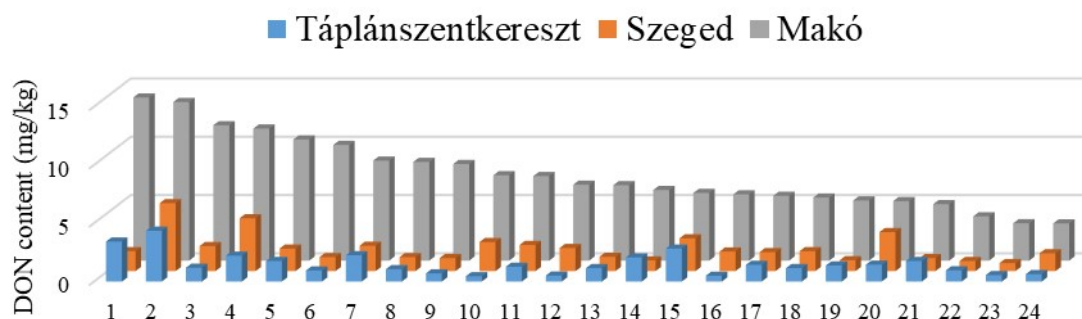


Figure 5. DON toxin contamination of different genotypes from Táplánszentkereszt, Szeged and Makó, 2019

We found only three genotypes on the two locations which had lower toxin contamination than the EU limit value and only two samples had lower toxin content than the most resistant control toxin level. It is essential to monitor the toxins in our cereals, because of the given circumstances, in case of same species there can be found extremely high differences. It is known that occurrence of natural infection is periodical, less predictable than the artificial inoculation results, but the data provide a useful feedback for the breeding work. It is important that wheat genotypes were identified with low DON contamination in both tests across two and three locations.

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ANALYSIS OF ENVIRONMENTAL PROTECTION EXPENDITURES AND THEIR INFLUENCE ON THE QUALITY OF THE ENVIRONMENT

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ABSTRACT

The environment is an important element in ensuring working and living conditions, but the evolution of industries, especially those polluting branches, have had the effect of deteriorating the quality of the environment. Measures to protect it are becoming increasingly necessary.

Environmental protection must be a priority in all aspects of our work, and we must look for ways to protect the Earth's resources for future generations.

In the article we have presented an analysis of the evolution of environmental protection expenditures. Environmental protection expenditure is the economic measure of the response of the community to solve environmental problems at a given time.

Companies in the national economy reserve funds for environmental protection activities. The amounts allocated differ from one sector of activity to another, but also from one year to another.

The field of environmental protection is considered very important for the population. Expenditures on environmental protection involve, on the one hand, expenditures for carrying out environmental surveillance and protection activities, and, on the other hand, expenditures related to the prevention or repair of damages caused to it.

It is found that the costs involved in environmental protection are greatly reduced when its degradation is prevented, compared to the situation in which it needs to be repaired.

The environment must be protected not only by the requirements of European directives but also by a national program to eliminate pollution.

Regarding the expenditures for environmental protection in Romania, the situation was much improved by increasing the amounts available, as a result of economic growth, but also of budget revenues.

Keywords: environment, resources, environmental protection.

INTRODUCTION

In this article, we aim to focus on environmental spending because the people is interested in issues related to both air and water pollution and the fact that the population is increasingly affected by global warming.

The environment and natural resources are the main elements of the functioning of the economic system. These are the "natural foundation of economic activities", which can accentuate or limit the development of society. (TOBULTOC, 2003)

In a document of the Council of the European Union "the environment means water, air and soil in their interaction, as well as the relationship between them and any other living organism" (art. 2, Council Directive of 27 June 1967).

According to the Romanian Constitution, the term environment is not expressly defined, but from art. 135 results that "the environment is the favorable framework for creating the necessary conditions for increasing the quality of life." (ROMANIAN CONSTITUTION)

Pollution, by inoculating matter or energy in the environment with destructive or harmful effects, affects ecosystems, reduces biological resources and affects human health (MUNTEANU et al., 2011)

Environmental issues are of a particular complexity, the causes being interdependent, which implies the need for actions at all levels: local, national and regional, each having a role in increasing responsibility for environmental protection (COMĂNESCU, 2010).

The environmental protection is in the focus of international institutions, which monitor the activity carried out by all countries in this field. It is noted that through the actions taken, Romania registers some positive results, being ahead of some European countries, but also from other continents. (MARINESCU et al., 2018)

Environmental protection considers several actions: rational management of resources, avoidance of imbalances by nature conservation, avoidance of environmental pollution, as well as its ecological reconstruction. Environmental protection measures include "establishing an obligation, establishing special conditions and stipulating prohibitions on the rational use of natural resources, preventing and combating environmental pollution and the harmful effects of natural phenomena on its components". These measures aim to maintain the ecological balance in order to ensure better living and working conditions for future generations. (KAPOSTA, 2009; VIŞAN et al., 2000)

The quality of the environment is the essential, inseparable element from the quality of life. The quality of the environment also positively affects economic growth, because it acts favorably on the primary factor of production - man, by maintaining health and reducing health care costs, but also contributing to ensuring and activating natural factors of production - the land and its full range of wealth. (GHEREŞ, 2007)

Environmental protection expenditure is an economic measure of society's response to addressing the issues involved in the state of the environment at a given stage. Included are the expenses for carrying out the activities of surveillance and protection of the environment and the expenses related to the prevention or repair of the damages brought to it. (FRĂSINEANU and BĂLOIU, 2007)

The motivation for choosing this theme was determined by the fact that a clean environment is the key element in ensuring working and living conditions.

The objective of the paper is to analyze the expenditure for environmental protection as it allows the evaluation of the effort made to prevent, reduce and eliminate pollution, considering that environmental protection contributes to stimulating the increase of quality of life.

MATERIALS AND METHODS

In order to carry out the work, we used, in addition to the specialized literature and include books, specialized works (FRĂSINEANU and BĂLOIU, 2007; GHEREŞ, 2007; KAPOSTA, 2009; MUNTEANU et al., 2011; VIŞAN et al., 2000) and data on environmental protection expenses extracted from the INS Statistical Yearbooks (INS, 2015-2020), on the basis of which we made our own interpretations, as presented in a number of tables and figures.

The method of scientific research used was the comparative analysis of expenditures by main categories of producers, in the period 2015-2020.

Environmental protection expenditures represent environmental financing flows and include payments for economic activities aimed at producing specific services to prevent, reduce or combat environmental damage. It is grouped into: current investments and expenditures that include internal current expenditures ("wages and social contributions, consumption of raw materials, fuels, energy, water and other auxiliary materials, expenditures for research and development, training, information, environmental

management") and external current expenses (expenses for environmental protection services purchased from third parties and for environmental taxes paid) (INS, 2020)

RESULTS

The expenditures for environmental protection in Romania were of approximately 16 billion lei, in 2019, representing 1.5 percentage points of GDP, according to the data provided by INS.

The expenses regarding the environmental protection were analyzed following the main categories of producers, presented in *Table 1*, so for the period 2015-2019 we would find the following: the expenses for environmental protection at non-specialized producers reached a maximum in 2015 (9,262,709 thousand lei); that the expenses for environmental protection of specialized producers decreased in 2016 (4,844,684 thousand lei), following an upward trend in the following years.

In the public administration sector, the expenditures doubled in 2019 in comparison with 2015.

Table 1. Evolution by sectors of activity of environmental protection expenditures

- RON thousand current prices-

Activity sectors	2015	2016	2017	2018	2019
Unspecialized producers	9,262,709	4,844,684	5,253,304	6,953,322	6,215,053
Forestry, logging and related service activities	46,675	269,955	246,967	270,720	36,003
Mining and quarrying	553,873	474,329	620,704	1,569,569	1,202,105
Manufacturing	2,940,678	1,269,102	1,357,311	1,367,959	1,525,097
Electric and thermal energy, gas and hot water production and supply	2,612,875	1,202,476	1,582,996	2,195,952	1,860,235
Water collection, treatment and supply	2,767,395	1,257,777	1,013,776	1,115,525	996,684
Construction	117,977	146,059	135,482	144,852	217,413
Transport	223,236	224,986	275,056	259,281	284,414
Other activities	-	-	21,012	29,464	93,102
Specialized producers	6,229,382	5,138,758	6,203,919	6,732,430	7,157,507
General government	4,507,534	5,520,700	4,310,403	7,180,500	9,207,400

Sources: www.insse.ro

Table 2. Expenditures on environmental protection by categories of producers and expenditures

- RON thousand current prices-

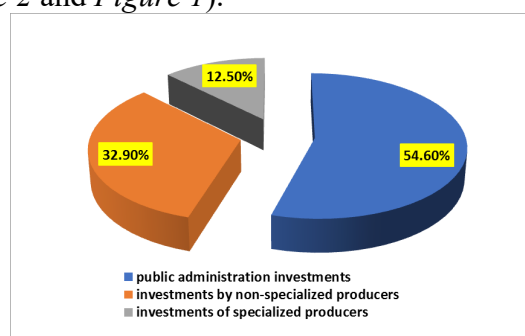
Types of producers	Investments	Current expenditure internal	Current expenditure external	Transfers
2015				
Unspecialized producers	4,828,570	2,706,216	1,727,923	-
Specialized producers	775,695	4,458,577	995,110	-
General government	1,140,763	1,530,528	1,687,356	
2016				
Unspecialized producers	1,233,658	1,507,782	2,103,244	-
Specialized producers	285,600	3,801,206	1,051,952	-
General government	1,485,200	709,018	1,166,683	2,159,800
2017				
Unspecialized producers	887,667	1,671,874	2,693,763	-
Specialized producers	266,043	4,449,551	1,488,325	-
General government	1,152,299	1,073,011	1,272,689	812,404
2018				
Unspecialized producers	1,657,409	1,947,580	3,348,333	-
Specialized producers	400,913	4,833,490	1,498,027	-
General government	1,434,900	1,147,962	1,356,038	3,241,600.00
2019				
Unspecialized producers	1,174,478	1,802,715	3,237,860	-
Specialized producers	446,773	4,925,477	1,785,257	-
General government	1,951,400	1,436,859	1,631,941	4,187,200

Sources: www.insse.ro

The structure of expenditures made by non-specialized producers in 2019 is as follows: in the field "production and supply of electricity and heat, gas and hot water" were recorded 29.93% of expenditures, while in the sector "manufacturing industry" 24.49% were achieved, while the "extractive industry" sector spent 19.34% of the expenses of non-specialized producers.

There is also a doubling of construction expenditures in the analyzed period.

At national level, the investment structure in 2019 was as follows: public administration investments represented 54.6% of total investments for environmental protection, investments of non-specialized producers 32.9% and investments of specialized producers 12.5% of the total (*Table 2 and Figure 1*).

**Figure. 1. Investments in environmental protection, by categories of producers, in 2019**Sources: www.insse.ro

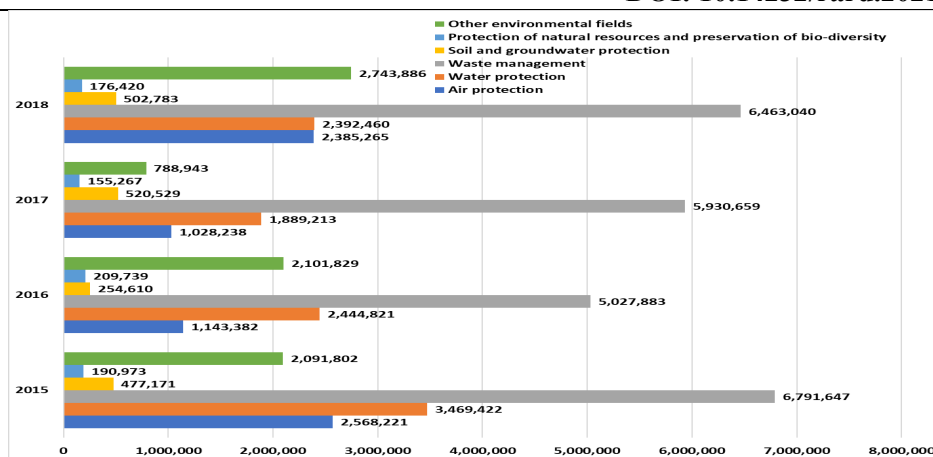


Figure 2. Structure of expenditures for environmental protection by environmental domains (RON thousand current prices)

Sources: www.insse.ro

By environmental areas (*Figure 2*) in 2019, the highest expenditures were registered in waste management, 42% of the total expenditures on environmental protection made at national level, then those for air and climate protection 19.8% and those for wastewater management (19.7%). Actions on environmental protection that are eligible for support under the National Framework include: "Air Protection, Wastewater Management, Waste Management, Soil and Groundwater Protection, Natural Resource Protection and Biodiversity Conservation, Other Environmental Areas".

In Table 3 we analyzed the evolution of environmental protection expenditures for non-specialized producers, by environmental fields, in the period 2015-2019 and we highlighted the following aspects: wastewater management expenditures decreased during the analyzed period approximately 2.5 times in 2019. The other categories of expenditures had an oscillating evolution: expenditures on waste management decreased in 2016, increased in the next two years, and in 2019 decreased, expenditures on soil and groundwater protection increased in year 2019, and expenditures with other environmental fields, were reduced 5.3 times in 2019 compared to 2015.

Table 3. Expenditures on environmental protection of non-specialized producers, by environmental fields

- RON thousand current prices -

Environmental fields	2015	2016	2017	2018	2019
Air protection	2,329,749	425,516	332,750	1,083,325	708,188
Water protection	2,522,504	1,251,416	997,224	1,056,911	1,076,796
Waste management	458,245	238,498	303,709	404,714	356,330
Soil and groundwater protection	416,369	233,235	409,870	408,108	495,963
Protection of natural resources and preservation of biodiversity	79,984	183,471	152,720	172,992	15,597
Other environmental fields	1,727,935	409,304	363,268	478,939	324,319

Sources: www.insse.ro

Table 4 shows the expenditures for environmental protection of specialized producers for the period 2015-2019 and we found the following: expenditures registered a sinuous evolution with increases followed by reductions. Expenditures on waste management decreased in 2016 (3,852,293 thousand lei), then followed increases from one year to another until 2019 (from 4,788,232 thousand lei in 2015 to 4,891,837 lei in 2019),

expenditures on wastewater management doubled from 2015 to 2019, and expenditures for other environmental areas decreased 29.55 times.

Table 4. Environmental protection costs of specialized producers, by environmental fields

- RON thousand current prices-

Environmental fields / Years	2015	2016	2017	2018	2019
Air protection	17,482	108,310	12,320	130,170	43,232
Water protection	129,453	61,849	76,041	77,580	278,926
Waste management	4,788,232	3,852,293	4,544,257	5,010,188	4,891,837
Soil and groundwater protection	20,795	8,709	51,995	3,941	146,146
Protection of natural resources and preservation of biodiversity	118	390	1,679	2,143	2,695
Other environmental fields	278,192	55,255	29,302	10,381	9,414

Sources: www.insse.ro

Table 5. Environmental expenditure of the public administration on environmental areas

- RON thousand current prices-

Environmental fields / Years	2015	2016	2017	2018	2019
Air protection	220,990	609,556	683,168	1,171,770	2,405,022
Water protection	817,465	1,131,556	815,948	1,257,969	1,774,562
Waste management	1,545,170	937,092	1,082,693	1,048,138	1,441,534
Soil and groundwater protection	40,007	12,666	58,664	90,734	608,175
Protection of natural resources and preservation of biodiversity	110,871	25,878	868	1,285	1,458
Other environmental fields	85,675	1,637,270	396,373	2,254,566	1,344,708

Sources: www.insse.ro

The expenses of the public administration presented in *Table 5*, increased between 2015-2019: the expenses with air protection increased significantly, from 220,990 thousand lei in 2015 to 2,405,022 thousand lei in 2019, 10.8 times; with other environmental areas have increased 15.69 times, spending on natural resources protection and biodiversity conservation decreased considerably 76 times in 2019, which has implications for quality of life because biodiversity is the primary condition of human civilization and ensures the support system of life and the development of socio-economic systems.

For the coming years, efforts to improve environmental protection measures must become a key concern for all parties involved in this field. In the vision of the Department for Environmental Protection, and of some European specialists, and according to some estimates, in the next 20 years, in order to keep the ecological balances as close as possible to the environmental standards, financial efforts of over 20 billion euros will have to be made so as to lead to ensuring a real protection on the economic evolution in Romania.

DISCUSSION

The results highlight the fact that man by building factories and plants, developing cities and transport, deforestation for wood use and growing agricultural areas, carelessly throwing large amounts of toxic waste into the water and air, has damaged the natural balance in the environment. It is thus necessary to ensure a much better ordered and protected evolution in the future, so that the quality of the environment is protected.

Pollution and environmental protection are among the most important problems facing Romania and humanity in general.

Global changes related to the quality of the environment involve finding solutions to maintain the ecological balance of the planet, in conditions of sustainable development.

We found that for the period 2015-2019, the environmental protection expenditures of non-specialized producers decreased, due to the increase in environmental protection expenditures of specialized producers, respectively those in the public administration sector.

In conclusion, for the next period it is necessary to further monitor these expenditures and especially the environmental protection measures must be intensified and emphasized, and in the polluting branches their evolution must be sufficiently protected on one hand, and on the other part must be ensured the mitigation of the effects of pollutants.

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GENETIC DIVERSITY OF SOYBEAN VARIETIES AND THEIR BIOLOGICAL POTENTIAL AS AFFECTED BY AGRONOMICAL PRACTICES

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ABSTRACT

The purpose of study was assess the genetic diversity of soybean varieties by SSR markers and investigate their productivity formation as affected by organic fertilizer, growth regulators and moisture retainer treatments in the Forest-Steppe zone of Ukraine. The effects of agronomical practices were assessed based on yield, protein and oil content. The study was carried out during 2016-2018.

As result it was found that the most similar varieties based on 4 SSR markers were varieties with genetic distances 1.73. The most different was Aliaska variety with genetic distances 3.16-3.87. Hieba, Kano and Ustia varieties, which are early-season varieties, were distributed in different clusters. It was determined that maximum of yield was obtained for Kano variety with combining moisture retainer, organic fertilizer and growth regulator "Vermystym D". The highest protein content in studied varieties was determined in case of combining organic fertilizer and growth regulators. The maximum of oil content was noted in Ustia and Kano varieties with application moisture retainer, organic fertilizer, growth regulators "Vermystym D". Thus, the biological features and applied nutrition affected studied indicators.

Keywords: molecular genetic polymorphism, DNA analysis, yield, protein and oil contained

INTRODUCTION

Every year all over the world, soybean (*Glycine max* (L.) Merr.) hybridization breeding programs include many lines and elite varieties of soybean (HUDCOVICOVA & KRAIC, 2003; ABUGALIEVA, 2013; RAMAZANOVA, 2016; LI *ET AL.*, 2017). During the breeding, developing varieties can be improved by new sources of genetic resources. Soybeans, in comparison with many types of agricultural plants, have a relatively low level of genetic variability (KUCHARIK & SERBIN, 2008; BABYCH & BABYCH-POBEREZHNIA, 2012; IVANYUK, 2012). Therefore, the development of approaches for genetic diversity assessment of soybean varieties is relevant for breeding. To date, specific SSR markers have been developed, which allow to assess genetic diversity of soybean varieties by PCR method for control the transfer of genetic material (PRYSIAZHNIUK *ET AL.*, 2017). A significant increase in the cultivated area of soybeans testifies to its extremely important role in the agrarian complex of Ukraine. The yield and product quality of soybeans is determined by a complex of factors and are formed with an optimal ratio of all elements (PRYSIAZHNIUK *ET AL.*, 2018A). The study of new agricultural practices is actual issue, because over the past decades there has been a significant breakthrough in the formation of ideas and the practical application of new micronutrient fertilizers and growth regulators. Thus, the study of growth regulators' and micronutrient fertilizers' effect was carried out by many scientists on various agricultural crops. In particular, majority of these researches proved the positive effect of these treatments on productivity formation of various agricultural crops, including soybeans (AZIZI *ET AL.*, 2012; DHAKNE *ET AL.*, 2015). In

addition, scientists note the positive effect of moisture retainer application (BAJAJ *ET AL.*, 2008; DEMIRTAS *ET AL.*, 2010). Thus, the purpose of study was to assess the genetic diversity of soybean varieties by SSR markers and investigate their productivity formation as affected by organic fertilizer, growth regulators and moisture retainer treatments in the Forest-Steppe zone of Ukraine.

MATERIALS AND METHODS

Twenty-three soybean varieties (Abelina, Alinda, Arnika, Berkana, DH 530, Kano, Hieba, DH 618, Monarkh, OAC Kalipso, OAC Lakeview, OAC Madok, Perlyna, Furio, Karra, Alaska, Arisa, Nordika, Amadeus, SG Eider, SG SR Picor, ASUKA, Ustia) were investigated by 4 SSR markers (Satt726, Satt063, Satt114 and Satt228) for genetic diversity assessment. The sample within each studied variety consisted of thirty individual DNA samples, combined in mixtures, six in each, which constituted five DNA mixtures for each variety, and PCR was performed (PRYSIAZHNIUK *ET AL.*, 2017). Molecular genetic analysis was carried out in Laboratory Molecular Genetic Analysis of Ukrainian Institute for Plant Variety Examination (Kyiv, Ukraine). Field experiment was performed at the experimental sites of Ltd “Research Institute of soybean” (Hlobyno, Poltava region).

Kano, Hieba and Ustia were studied as affected by moisture retainer Aquasorb, organic fertilizer Parostok, growth regulators Vermystym D and Ahrostymulin. The treatments were carried out as described in our previous study (PRYSIAZHNIUK *ET AL.*, 2018B). The sown area was 54 m², and the record area was 35 m² with 3 replications. The weather conditions in 2016 and 2018 differed from daily average values, however, in general, they were favorable for soybean cultivation. During the growing season of 2017, amount of precipitation was 202 mm which was half as compared to 2016 (412 mm).

The effects of agronomical practices were assessed based on yield, protein and oil content. The oil and protein content were determined using an Infraneo infrared grain analyzer (CHOPIN Technologies, France), calibrated with standard samples provided by Ukrmetrteststandard (TKACHYK, 2017). Statistical analysis of experimental data was performed using STATISTICA 12.0 software (trial version) (ERMANTRAUT *ET AL.*, 2007).

RESULTS AND DISCUSSION

As result of 23 soybean varieties DNA analysis by four SSR markers alleles of expected size were identified. It was found that from 3 to 7 varieties were polymorphic by studied SSR markers. Alinda variety had two alleles by all studied markers. Alaska variety had three alleles by Satt726 marker, ASUKA variety had 3 alleles and Hieba variety had 2 alleles by Satt114 marker. Thus, intra-variety polymorphism should be taken into account while the authenticity of soybean varieties is determined. It should be noted that majority of the studied varieties had one locus per marker. The number of identified alleles varied from 10 to 16 per marker. It was shown that the most polymorphic marker was Satt726 (PIC 0.92). For other markers PIC was 0.82-0.91 (*Table 1*).

Table 1. Characteristics of the studied loci

SSR marker	Number of alleles	Allele size (bp)	PIC
Satt228	14	207-269	0.91
Satt726	16	188-275	0.92
Satt063	14	105-201	0.90
Satt114	10	77-125	0.82

Thus, the obtained high PIC values (0.89 on average), indicate that the identified alleles are evenly represented among soybean varieties.

In order to analyze the polymorphism of 23 soya varieties by SSR markers traits, a cluster analysis was carried out and genetic distances between the varieties were calculated (*Figure 1*).

As results of cluster analysis eight clusters were obtained by Satt063, Satt114, Satt228 and Satt726 markers. It was found that clusters were formed by Abelina and Berkana; DH 618 and OAC Kalipso; Kano, Karra and SG SR Picor; ASUKA and Ustia; Furio and Amadeus; DH 530 and Monarkh; OAC Lakeview and SG Eider; Alaska and Arisa varieties.

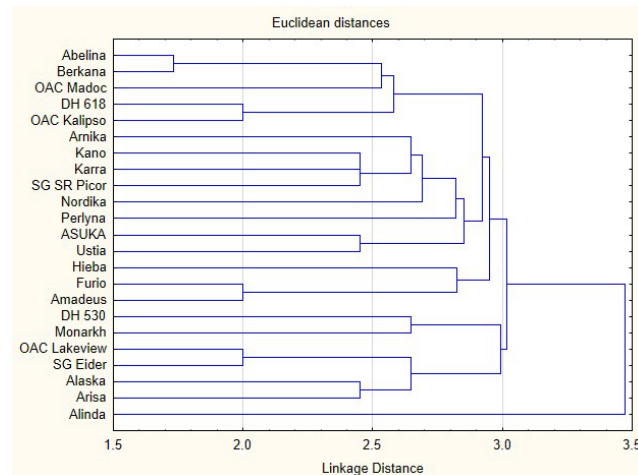


Figure 1. Dendrogram of soybean varieties by SSR markers

Analysis of genetic distances of the studied soybean varieties showed that the largest distance was between Alaska and Alinda (3.87) varieties. With the increase of the affinity of the varieties, their genetic distances shorten. In this study, the most similar varieties were Abelina and Berkana with the genetic distance 1.73. It should be noted that the most distinct variety by studied SSR markers was Alinda variety with genetic distances 3.16-3.87. Alaska variety was rather distinct with genetic distances 2.65-3.87. Even though this variety was included in cluster with Arisa variety it turned out to be the closer to OAC Lakeview variety. The distances between the majority of varieties varied from 2.00 to 3.46. Hieba, Kano and Ustia varieties, which are early-season varieties, were distributed in different clusters.

The molecular genetic polymorphism of soybean varieties with SSR markers was assessed by PAGAR *ET AL.* (2017). Authors studied thirteen soybean genotypes which were screened using 31 polymorphic SSR markers. The pair wise coefficient of genetic similarity between all soybean genotypes ranged from 0.792 to 0.929. It was determined that the unique bands can be used for the identification of specific soybean genotype. SONG *ET AL.* (2004) developed 391 SSR markers for soybean. Authors showed that SSRs were not uniformly spaced over a linkage group, clusters of SSRs with very limited recombination were frequently present. The part of this markers set was used in this study. Thus, SSR markers Satt063, Satt114, Satt228 and Satt726 were effective for genetic diversity assessment of studied varieties. They allowed to differ 23 soybean varieties according to genetic distances and shown the most similar and distinct varieties.

The biological potential of soybean varieties which belonged to the same maturity group was assessed by combining moisture retainer, organic fertilizer, growth regulators treatments. The affects were estimated by yield, protein and oil content of three soybean varieties.

It was determined that the average yield for 2016-2018 of studied varieties was: Kano variety - 4.87, Hieba variety – 2.76 and Ustia variety – 3.10 t/ha (*Figure 2*).

The studied agronomical practices influenced the soybean yield in different ways. The lowest yield of all studied varieties was obtained without any treatments: Kano - 4.43, Hieba - 1.91, Ustia - 2.70 t/ha. It was found that yield of all studied varieties was increased with organic fertilizer treatment: Kano – 4.99, Hieba – 2.43, Ustia – 3.21 t/ha which significantly differed from control variant without any treatments. It should be noted that treatments by growth regulators Vermystym D or Ahrostymulin did not affect significantly yield of Kano and Ustia varieties.

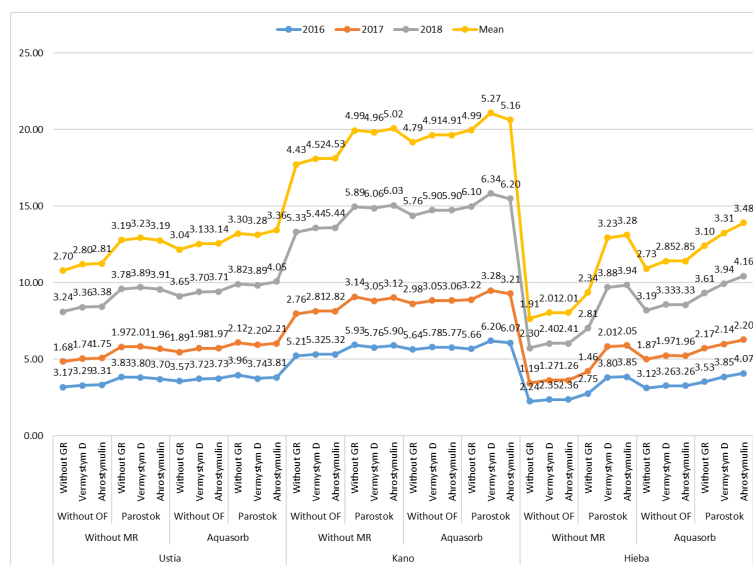


Figure 2. Yield of soybean varieties for 2016-2018, t/ha (LSD_{0.5}: 2016 – 0.23, 2017 – 0.20, 2018 – 0.24 t/ha, mean – 0.27 t/ha)

For Hieba variety the treatment by growth regulators Vermystym D and Ahrostymulin increased the yield significantly. The yields of Hieba variety in this variant were 3.23 and 3.28 t/ha, respectively. In variant of complex treatment by organic fertilizer and moisture retainer, the yield of Kano variety was 5.14 t/ha. Additionally, combining of growth regulators treatment with organic fertilizer and moisture retainer was most efficiency for Kano variety yield increasing by 0.28 t/ha with Vermystym D and by 0.17 t/ha with Ahrostymulin. The combining organic fertilizer and moisture retainer treatment allowed to obtain higher yield of Hieba variety – 3.10 t/ha. The most efficient was treatment by growth regulators Vermystym D or Ahrostymulin, the yield of Hieba variety increased by 0.21 and 0.37 t/ha respectively. Thus, proposed agronomical practices allow to significantly increase the yield of soybeans even under favorable conditions for plant development. In particular, for Kano variety, the minimum yield was obtained in control variant without any treatments - 4.43 t/ha, and the maximum - 5.27 t/ha - with combined treatments, for Hieba variety - 1.91 and 3.48 t/ha, and for Ustia variety - 2.70 and 3.36 t/ha, respectively.

The qualitative characteristics of soybean seeds are an important complex feature for obtaining a high-quality yield. It is known that foliar application of fertilizers and growth regulators has a positive effect both on plants productivity and the quality characteristics of the soybean yield. The protein content is major characteristic of soybean seeds. The soybean varieties with high protein content have more essential amino acids – 22.5% while essential amino acids content in varieties with low protein content is 17.8%. The protein

content of studied soybean varieties according to moisture retainer, organic fertilizer, growth regulators treatments is represented in *Figure 3*.

As result of this study, it was determined that different combination of moisture retainer, organic fertilizer, growth regulators treatments affected protein content in different ways. In particular, in control variant, Kano variety contained 43.1% of protein in seeds, Hieba and Ustia varieties - 39.8 and 41.1%, respectively. It was found that moisture retainer application did not affect protein content of soybean varieties significantly. The organic fertilizer treatment allowed to increase protein content in seeds of Kano variety by 0.81%, Hieba variety – by 1.24 and Ustia variety – by 0.76%. The highest values of this characteristic were obtained in variant of combining organic fertilizer and growth regulators treatments. In particular, the protein content in Hieba variety in variant of organic fertilizer and growth regulator Vermystym D application was 41.9%, in variant of organic fertilizer and growth regulator Ahrostymulin – 44.8%; in Kano variety – 45.0%, in Ustia variety – 42.0% in both variants, respectively.

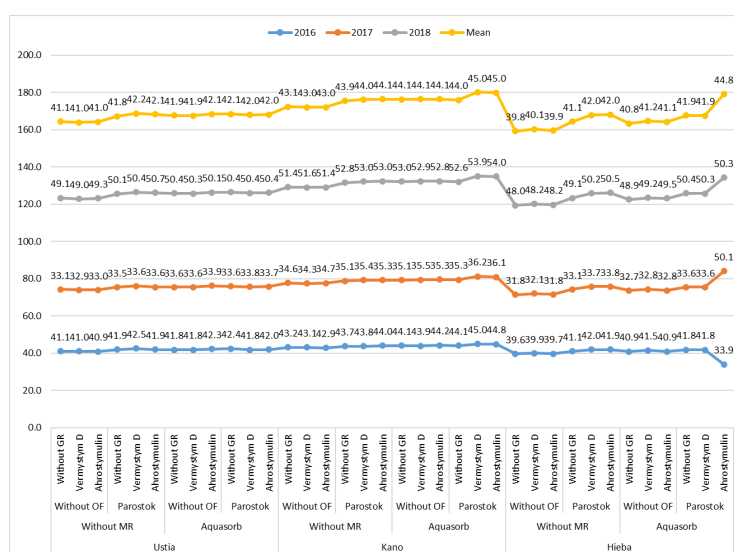


Figure 3. The protein content of soybean varieties for 2016-2018, % (LSD_{0.5}: 2016 – 1.10, 2017 – 1.00, 2018 – 1.20%, mean – 1.70%)

According to obtained results, it can be concluded that organic fertilizer followed by growth regulators treatments can significantly improve soybean products quality due to increased content of protein.

The major of researchers proves that an increase in the protein content occurs under conditions of insufficient precipitation and high air temperature during yield formation (PETRYCHENKO, 2006; ASSEFA *ET AL.*, 2018; MERTZ-HENNING *ET AL.*, 2018; ALSAJRI *ET AL.*, 2020). It should be pointed that during the studied years the variability of weather conditions was noted during pod formation and ripening period of soybean. In particular, the air temperature in August 2016, 2017 and 2018 was higher than daily average value by 4.0, 3.9 and 3.1°C, respectively. At the same time amounts of precipitation was by 7.0; 40.0 and 46.3 mm less than daily average amounts of precipitation, respectively.

On average, according to obtained results, the oil content in seeds of Ustia variety was 19.8%, Kano variety - 21.8, and Hieba - 21.8% (*Figure 4*).

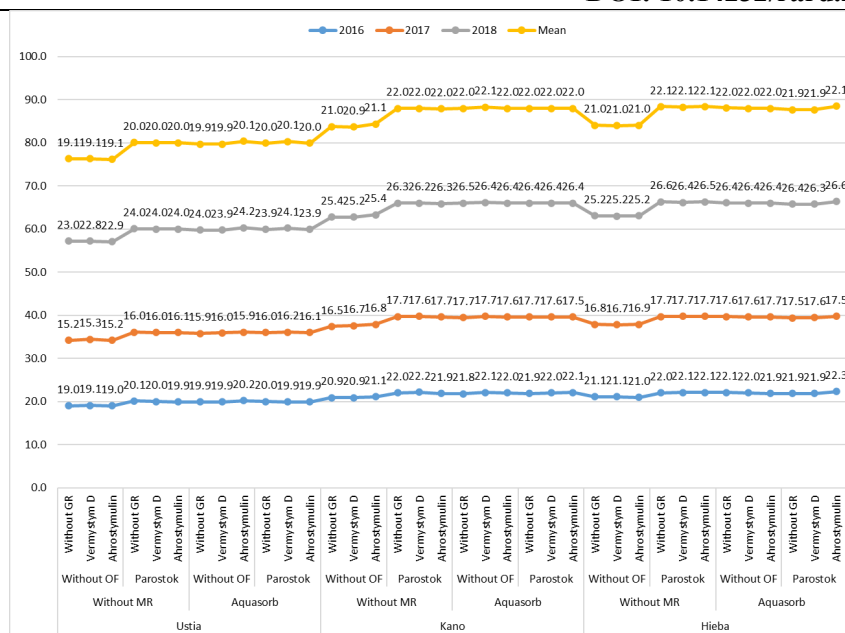


Figure 4. The oil content of soybean varieties for 2016-2018, % (LSD_{0.5}: 2016 – 0.40, 2017 – 0.30, 2018 – 0.50%, mean – 0.40%)

The maximum values of oil content were in varieties Ustia and Kano in the variant of combining moisture retainer, organic fertilizer and growth regulators Vermystym D and Ahrostymulin - 20.1 and 22.0%, respectively. In Hieba variety, the highest value of oil content in seeds was obtained as affected by hydrogel and organic fertilizer combined with the growth regulator Ahrostymulin - 22.1%. This means that the oil content in soybean seeds was largely influenced by the biological characteristics of plants and agronomical practices.

Temperatures that vary spatially and temporally over the soybean growing areas affect soybean seed yield and quality (ALSAJRI *ET AL.*, 2020). Authors proved that the cultivar × temperature interaction was significant for total biomass, seed yield, protein and oil content. This study showed that the influence of air temperature increasing during growing season of soybean can be minimized by moisture retainer, organic fertilizer and growth regulator treatments. ASSEFA *ET AL.* (2018) found out that variability in genotype × management × environment influencing affected soybean yield, protein and oil content. The similar study was carried out by DHAKNE *ET AL.* (2015). They showed that application of growth regulator recorded significantly higher soybean yield.

Therefore, for obtaining high yield and good seed quality of soybean, it is necessary to use a set of additional treatments that contribute to optimization of nutrition and regulation of growth and development processes of plants.

CONCLUSIONS

As the results of this study, it was determined that the most polymorphic SSR marker was Satt726. There were detected 16 alleles in studied soybean varieties (PIC 0.92). It was found out that the identified alleles of microsatellite loci are fairly evenly represented in soybean varieties, as evidenced by the high PIC values (0.82-0.92). According to cluster analysis, the most similar varieties based on 4 SSR markers were varieties with genetic distances 1.73. The most different was Aliaska variety with genetic distances 3.16-3.87. All studied varieties were distributed to 8 clusters. This indicates the high level of differential ability of marker system.

The highest yield in the experiment was obtained in Kano variety with complex treatments of Aquasorb moisture retainer, Parostok organic fertilizer and the plant growth regulator Vermystym D - 5.27 t/ha. The maximum of protein content was obtained in variants of the complex treatments of organic fertilizers and growth regulators for all of studied varieties. The maximum values of oil content were noted in Ustia and Kano varieties combined effect of factors - Aquasorb, organic fertilizer Parostok and growth regulator Vermystym D - 20.1 and 22.0%, respectively.

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**FIRST RECORD OF *DACTYLOGYRUS VASTATOR* (NYBELIN 1924)
(MONOGENEA: DACTYLOGYRIDAE) IN COMMON CARP (*CYPRINUS
CARPIO* LINNAEUS, 1758) FROM AQUACULTURE FACILITIES IN
MACEDONIA**

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ABSTRACT

The representatives of the class Monogenea are of great importance in fish pathology. *Dactylogyrus vastator* (Nybelin 1924) (Monogenea: Dactylogyridae) is a common pathogenic monogenean parasite in common carp (*Cyprinus carpio* Linnaeus, 1758) from freshwater lakes and cyprinid ponds, worldwide. In our study, a total of 133 specimens of common carp from the cage culture system on Mladost Reservoir (N. Macedonia) were subjected to a parasitological investigation, by seasons. Only fresh fish were subjected to routine identification, dissection, and observation methods. Parasite identification was performed morphologically, based on the character of significant organs, using referent keys for determination. *Dactylogyrus vastator* was found in winter, on gills of 27 specimens of common carp, with a prevalence of 2.818%, and mean intensity of 6.850. During our research, the presence of *Dactylogyrus vastator* was found in an aquaculture facility with a very high fish stock density. This parasite species would lead to fish mortality and it depends primarily on the mean intensity, the fish condition, and size, as well as the water temperature and oxygen content. The records of *Dactylogyrus vastator* in common carp in the present study are considered as the first records in N. Macedonia. The common carp is regarded as a new host for these parasite species in Macedonian aquaculture.

Keywords: monogenean, parasites, common carp, cage culture system

INTRODUCTION

The class Monogenea are of great importance in fish pathology. Most of the Monogenea are ectoparasites with a direct life cycle. According to BUCHMANN & BRESCIANI (2006), monogenean trematodes are hermaphroditic plate worms that complete their life cycle in a single host. The family Dactylogyridae which belong to the class Monogenea includes a large number of parasitic species that are the most common gill parasites of freshwater fishes (WOO 2006). DOVE & ERNST (1998) state that *Dactylogyrus* is one of the largest genera of parasitic helminths, 95% of which are gill parasites in fish of the family Cyprinidae.

According to GIBSON ET AL. (1996), the genus *Dactylogyrus* Diesing, 1850 (Dactylogyridae) includes more than 900 nominal species. *Dactylogyrus* parasites cause serious infections in the gill filaments causing impaired respiration and resulting in high mortalities (JIANG ET AL. 2013; TU ET AL. 2015) as well as significant economic losses in aquaculture (WOO ET AL. 2002).

In the present study, *Dactylogyrus vastator* (NYBELIN 1924) (Monogenea: Dactylogyridae) was identified from gill filaments of common carp (*Cyprinus carpio* Linnaeus, 1758) from the cage culture system on Mladost Reservoir (Macedonia) using a morphological approach.

MATERIALS AND METHODS

Fish material from a total of 133 specimens of common carp (*Cyprinus carpio*, L. 1758) from the cage culture system on Mladost Reservoir (N. Macedonia) was subjected to a parasitological investigation, by seasons. Only fresh fish were subjected to routine identification, dissection, and observation methods. Cleaned parasites were separated and put in certain fixatives, prepared for determination with determined techniques of staining and clearing (Vasiljkov, 1983; Gussev, 1983). Parasites on native smears are observed under a light microscope at magnification $\times 200$ and $\times 400$.

For the collection of *Dactylogyrus* species, gill filaments were examined using the stereomicroscopes „Zeiss”- Stemi DV4 and „MBS 10” and parasites were removed. For morphological examination, permanent slides of whole individual parasites were prepared by staining with acetocarmine, dehydrating with ascending grades of alcohol and mounting in Canada balsam. For the study of sclerotized structures, whole parasites were cleared gradually in water and mounted in glycerin. Specimens were examined using a light microscope „Reichert”. Identification was made through the morphology of haptor hard parts and the copulatory complex.

Classical epidemiological variables (prevalence and mean intensity) were calculated according to BUSH ET AL. (1997). The parasite specimens were identified using reference keys of BAUER (1985, 1987) and GUSSEV (1983).

RESULTS

Dactylogyrus vastator was found on the gills of 27 specimens of common carp from the cage culture system on Mladost Reservoir (N. Macedonia) in winter, with the prevalence of 2.818%, while the mean intensity was 6.850 (Table 1.).

Table 1. Prevalence (P) and mean intensity (I) with *Dactylogyrus vastator* in common carp from the aquaculture facility in N. Macedonia, by seasons

Parasite species	Spring		Summer		Autumn		Winter	
	I	E (%)	I	E (%)	I	E (%)	I	E (%)
<i>Dactylogyrus vastator</i>	/	/	/	/	/	/	6.850	2.381

Dactylogyrus vastator is a large parasite, with a body length of up to 1.25 mm and a width of up to 0.48 mm. The middle hooks are characterized by the following dimensions: length of the general part 0.038 - 0.048 mm; base part 0.036 - 0.038 mm; internal growth 0.019 - 0.021 mm; external growth 0.009 - 0.011 mm. The sharp part is small and ranges from 0.004 - 0.005 mm. There is only one connecting plate with dimensions 0.007 - 0.008 \times 0.024 - 0.032 mm. The length of the peripheral hooks is from 0.030 - 0.035 mm. The length of the copulatory organ ranges from 0.045 - 0.055 mm.

The parasites were identified using morphometric measurements of hard parts, the morphology of the haptor parts, and the shape of the male copulatory organ.

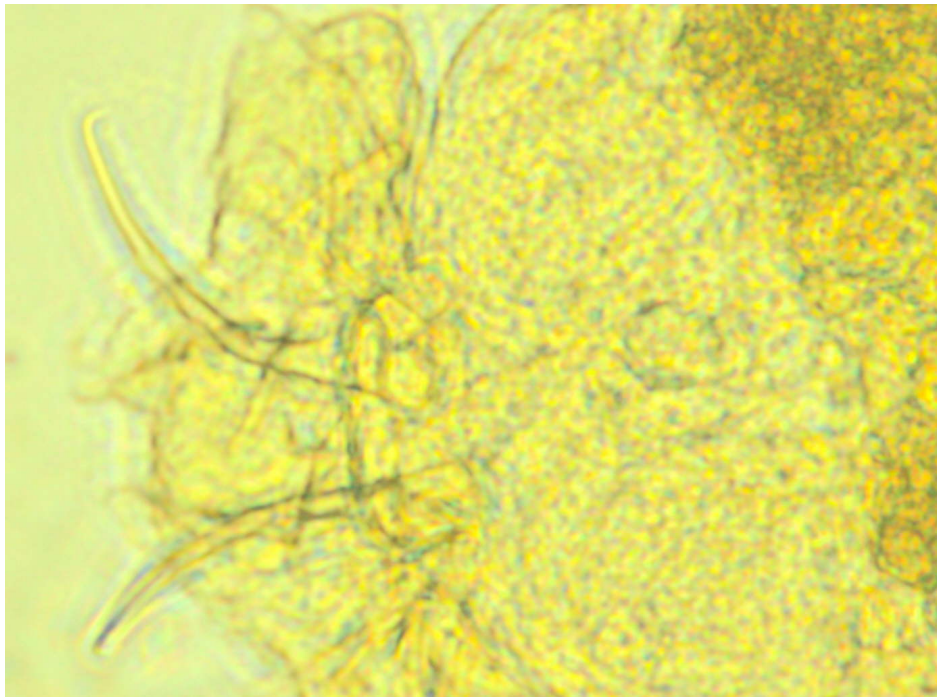


Figure 1. *Dactylogyrus vastator* on gills in common carp – hooks (original)

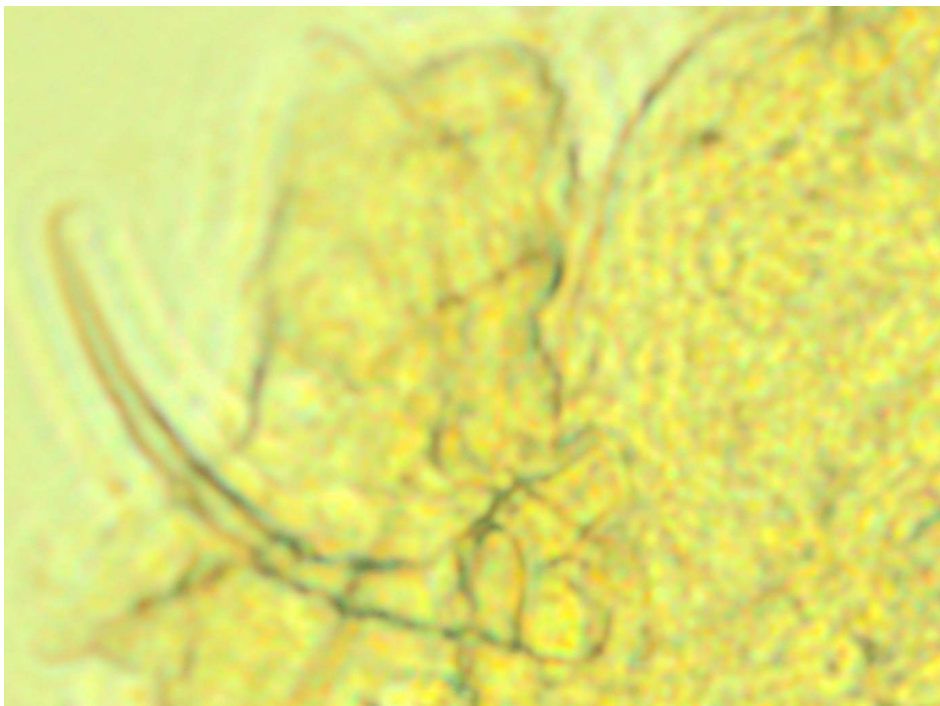


Figure 2. *Dactylogyrus vastator* on gills in common carp – hooks (original)

DISCUSSION

Dactylogyrus vastator is a typical parasite that attacks the tips of the gill filaments of common carp. It is a highly pathogenic species, especially for young carp with a length of 2 - 5 cm. Diseased fish consume little food. The color of the gills fades, they are covered

with mucus, and in some places, blood clots form. This parasite causes impaired respiratory function in fish, so due to the impossibility of normal breathing, they die.

According to KAKACEVA-AVRAMOVA (1983), *Dactylogyrus vastator* causes mortality in fish with a length of 2.5 cm, whose gills parasitize 60-80 specimens, as well as in fish with a length of 3.5 - 4.0 cm, on whose gills parasitize 140 - 160 specimens of this parasite. ČANKOVIĆ ET AL. (1976) state that *Dactylogyrus vastator* is a highly pathogenic species for young carp with a length of 2-5 cm. Parasites, during strong invasions, are distributed over the entire surface of the gill filaments, which causes severe pathological changes and significant losses in the offspring.

According to the data from previous parasitological researches in Macedonia, *Dactylogyrus vastator* was found only in *Carassius gibelio* (prussian carp) from Lake Ohrid, Prespa, and Dojran, by STOJANOVSKI (2003), which is the first data on the presence of this parasite in our country. HRISTOVSKI ET AL. (2006, 2012) found the *Dactylogyrus vastator* in *Carassius gibelio* from Lake Prespa.

According to the literature reviews of the Balkan countries, the presence of *Dactylogyrus vastator* at common carp in Bosnia and Herzegovina was established by TESERČIK & IVASIK (1973) in the carp fish pond "Majdan"; KIŠKAROLY ET AL. (1980) and KIŠKAROLY (1987) in carp fish pond "Bardac", "Prnjavor" and "Sanicani" in Prijedor; ČANKOVIĆ ET AL. (1976) in carp fish pond "Vucijak" in Prnjavor. In waters in Bulgaria, this finding was established by MARGARITOV (1962); in the Seyhan River in Turkey by CENGIZLER ET AL. (2001), while in fish ponds in Romania by RADU ET AL. (2008).

According to world literature, data on the presence of *Dactylogyrus vastator* in common carp were published by SHAMSI ET AL. (2009) from fishponds in Iran and HOFFMANN (1999) from fishponds in California and southern Ontario, with enormous damage and high mortality in the fish population.

Dactylogyrus vastator is a fairly common parasite in freshwater lakes and cyprinid ponds. Due to the special sensitivity of this parasite to water hardness, pH, and NH₃, it does not occur in common carp which live in lakes or fish ponds with high alkalinity (JALALI & MOLNÁR, 1990a). ŠIMKOVÁ ET AL. (2007) concluded that these parasites mainly infecting cyprinid fishes.

During our research, the presence of *Dactylogyrus vastator* was determined in a cage fish farm with a very high fish stock density. *Dactylogyrus vastator* was found in winter, on gills of 27 specimens of common carp, with a prevalence of 2.818%, and mean intensity of 6.850. Whether this parasite would lead to fish mortality, depends primarily on the mean intensity, the fish condition, and size, as well as the water temperature and oxygen content.

The records of *Dactylogyrus vastator* in common carp in the present study are considered as the first records in N. Macedonia. The common carp is regarded as a new host for these parasite species in Macedonian aquaculture.

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SUSTAINABLE DEVELOPMENT GOALS IN ECOVILLAGES**BOGLÁRKA RITA NAGY^{1*}, ATTILA VARGA², ÁGNES SALLAY¹**

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ABSTRACT

In 2015 the Sustainable Development Goals (SDGs) were ratified by 195 countries. To be achieved by 2030, the goals aim to transform our world by leaving no one behind. In 2017 the Global Ecovillage Network (GEN) investigated how 30 ecovillages from 5 continents already contributed to the UN SDGs. The results were presented on the 2018 High-Level Political Forum (HLPF). Based on the GEN research outcomes, we examined 17 international Ecovillages. We aimed to understand how ecovillages relate to the UN SDG framework. The research was done with Ecovillages Around the World subject students. Before the analysis, students became acquainted with the SDGs' targets and their implications in different communities. The research methods were web-content analysis and self-assessment from the ecovillages' representatives, and the results were compared. The research proved that studied ecovillages already contribute to most SDGs; still, most do not know or intend to use the SDG framework. The results indicate a communication gap between the global political community and local ecovillages. Both global and local efforts aim to support sustainable development, but there could be vast differences in the interpretation of sustainability. Therefore, there is a significant need to establish communication channels and platforms to support the partnership between stakeholder groups working for sustainability at different levels.

Keywords: Ecovillage, SDGs, Empty Signifier, Sustainability

INTRODUCTION

Ecovillages are local communities that implement a complex ecological lifestyle alternative and are located as separate settlements or districts of settlements that serve as the residence of a community. Takács-Sánta defines a community as “a group of people who: (1) interact with each other on a regular and frequent personal basis, and communicate with each other in the same space at regular intervals; (2) they are linked by a similar set of values and worldview (i.e., the mindset of community members is fundamentally similar); and (3) have common practical goals and work together to achieve them. It is also important that (4) they consist of at least three (sometimes hundreds) adult members who represent at least two separate lines of kinship” (TAKÁCS-SÁNTA 2016).

The ecovillage concept and practice are determined by the need for autonomy in infrastructure, food and management. It is a small-scale community living in harmony with nature and resilient to global economic and social processes. The urban-consumer social dependence is replaced by dependence on nature. Ecovillages choose dependence on nature as means of voluntary simplicity. They are saving water as a valued resource, choosing agriculture or building materials that fit into the natural environment and adapting to the weather and the rhythms of nature (FARKAS 2017; TAKÁCS-SÁNTA 2017).

The 17 UN SDGs are to be achieved by 2030, and the two ambitious mottos of the program are: “Transforming our world!” and “Leave no one behind!” (UNSDG, 2021)

Ecovillages have been working for sustainability for decades, even before the UN SDG agenda. In 2017, GEN investigated how 30 ecovillages from 5 continents contributed to the 17 UN SDGs (GEN 2019). The GEN studied ecovillages' practices contribute to the SDG4 (Quality Education), SDG5 (Gender Equality), SDG6 (Clean Water and Sanitation), SDG11 (Sustainable Cities and Communities), SDG12 (Responsible Consumption and Production), SDG13 (Climate Action), SDG15 (Life on Land), SDG16 (Peace Justice and Strong Institutions), and SDG17 (Partnerships for the Goals) (UN 2017). SDG as a framework could promote the good practices of the ecovillages in the wider territorial region. These communities are living laboratories that use good practices which contribute to the SDGs locally. Scaling up these good practices to the territorial or regional level would benefit global SDG efforts.

When SDGs try to exhaustively cover all global sustainability challenges, they inevitably become vague, highly variable, and unspecific, and become empty signifiers. Empty signifiers representing a vague, highly variable, unspecific, or non-existent signified (OXFORD 2018). Empty signifiers could emerge when a concept (in this case, sustainable development) becomes a central point of a social value system as all interest groups start to link themselves to this value in many cases without authenticity. Let us also consider that, as Laclau states, empty signifiers are often tools for implementing particular interests (LACLAU 1991), and SDGs are a product of protracted political negotiations. We could gain insight into why there is a significant possibility that SDGs work as empty signifiers for many stakeholders.

If we want to avoid SDGs becoming empty signifiers, continuous, open and two-way communication between the central level (e.g., UN) and local level (e.g., ecovillages) is needed, making it possible to interpret SDGs differently in various settings. Central level bodies should encourage regional organizations and local communities to reflect on SDGs and develop their own regional and local interpretation. They should choose the regionally and locally most relevant goals and targets and even define their own goals and targets linked to the SDGs.

MATERIALS AND METHODS

The research process examined the 17 SDG in 17 ecovillages from five continents (*Table 1*). It aimed to prove that ecovillages can play an essential role in achieving the SDGs.

Seventeen ecovillages from Hungary and abroad were chosen for the study. Some were partners of the GEN network (GEN N.D.), and others from personal and professional contacts (*Table 1*). As the GEN report did not name the involved ecovillages, we do not know if there were any overlap in the researched ecovillages.

The GEN (GEN 2019) research report was studied, and relevant data were collected from it. The ecovillages' self-assessment, the GEN data, and web-content analysis results were compared in Excel diagrams.

Table 1: Researched ecovillages

EUROPE		
1	Switzerland:	Schloss Glarisegg
2	Germany:	LandGut Girtenmühle
3	Tenerife:	As. Manantial de Tara
4	Denmark:	Ecovillage Dyssekilde
5	Germany:	ZEGG
6	Hungary	Nyim ecovillage
7	Hungary	Auromag
8	Hungary	Krisnavölgy
9	Poland:	Aranya
10	Ireland:	Cloughrojdán ecovillage
AFRICA		
11	Senegal:	Adunam ecovillage
AMERICA		
12	USA:	Our ecovillage
13	Canada:	Ideal Society
ASIA		
14	China:	Southern Life Community
15	India:	Auroville
16	Jordan	Alia Ecovillage
17	AUSTRALIA	Alia Ecoi-village

Web-content analysis:

The research was conducted with the students of the Ecovillages Around the World subject. As a preparation for the web-content analysis, the students became acquainted with the SDGs' targets and their implications in communities, and lecturers from six communities presented their activities, good practices, and aims through the 17 SDGs.

The ecovillages' online communication materials on their websites, online publications, and social platforms were examined. For each SDG, we mapped the planned and implemented activities, good practices and aims of the ecovillages. We compiled the found information in word documents, from which the needed data were dissembled into excel sheets.

Questionnaire-Ecovillages' self-assessment

The ecovillages answered a questionnaire. The core of the questionnaire was built on the nrg4SD 2018 HLPF research report (NRG4SD 2018). Before the survey, initial interviews were held with six representatives of international and Hungarian ecovillages. Based on the interviews, the questionnaire was modified. Questionnaire data were compiled into Excel spreadsheets, including explanatory answers from the "Other" options.

SDG 6 Localizing workshop assessment

The ecovillages self-assessment showed an empty signifier and irrelevance perception of SDGs. The SDG 6 Localizing Workshops were used to test if the SDG perception of 20 members of two Hungarian ecovillages can be shifted. In the workshop, the eight targets of SDG6 were filled with local content. The representatives indicated the SDGs relevant to the aims and activities of their communities before and after the workshop.

RESULTS

In the questionnaire, the communities identified each SDGs' relevance to their aims and work. The 2018 GEN research (GEN 2019) and the 17 studied ecovillages had nine

examined SDGs in common, and the results of GEN were higher on those SDGs (Figure 1).

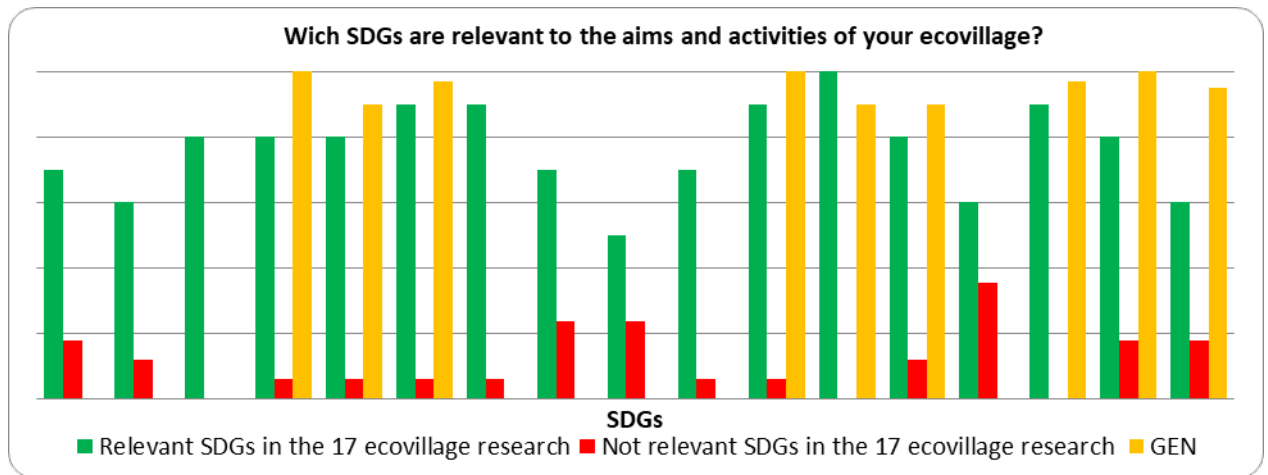


Figure 1. Self-assessment on SDG relevance

The research aimed to identify how many goals are perceived as irrelevant to the community’s aims and activities (Figure 2).

Among the 17 ecovillages, seven identified all SDGs as relevant to their aims and works, and four mentioned only one SDG as irrelevant. However, the chart shows that 35% of the communities identified more than one goal as irrelevant. One ecovillage marked as many as 12 goals as irrelevant to the community’s aims and works. Different information was found through the web-content analysis, where we found matching activities, good practices, or ambitions related to each SDGs at most ecovillage (Figure 3).

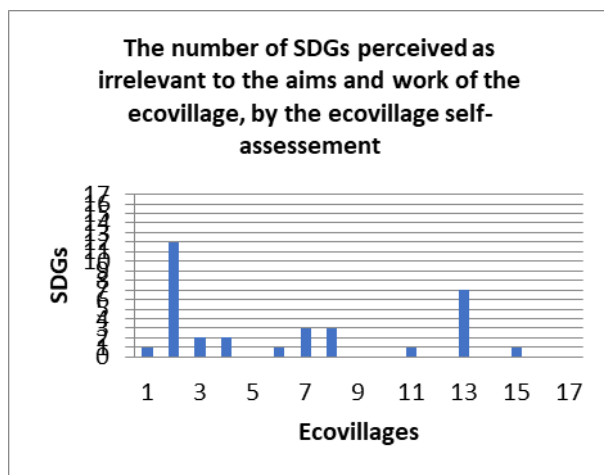


Figure 2. The number of irrelevant SDGs by the ecovillages’ questionnaire

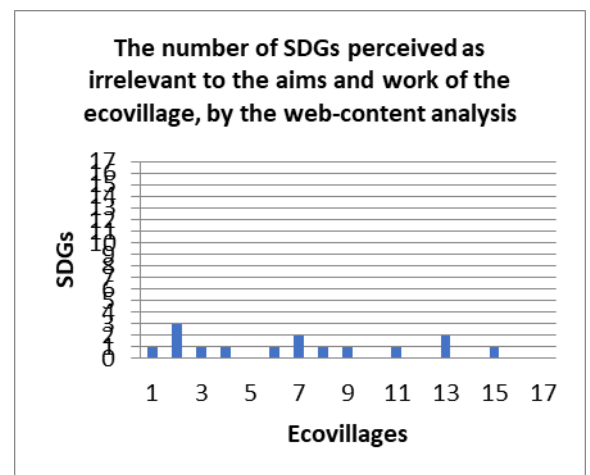


Figure 3. The number of irrelevant SDGs by the web-content analysis

In many cases, the web-content analysis did not correspond with the ecovillages self-assessment. Students who studied SDGs with all their targets and indicators found that many ecovillages were unaware of the SDGs’ detailed meaning. For instance, several communities working with organic agriculture indicated SDG 2 (Zero Hunger) as

irrelevant. On the UN pictogram of SDG 2, „Zero Hunger” is written; however, this goal has five targets relevant to organic agriculture practices.

We were curious to see how strongly these communities use the SDGs to refer to when describing their activities.

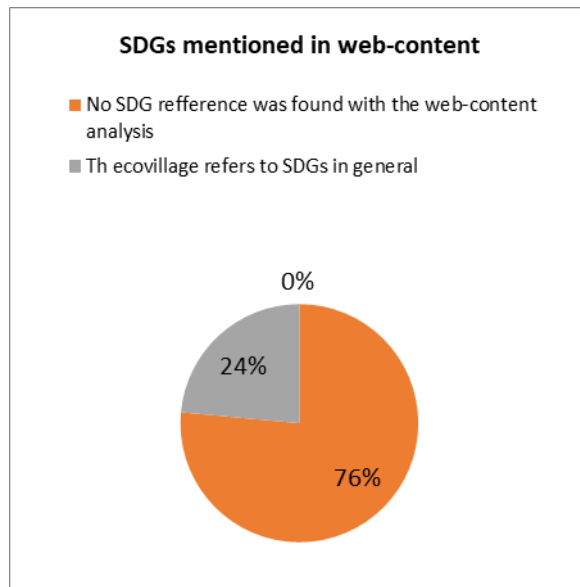


Figure 4-Communicating SDGs- web-content analysis

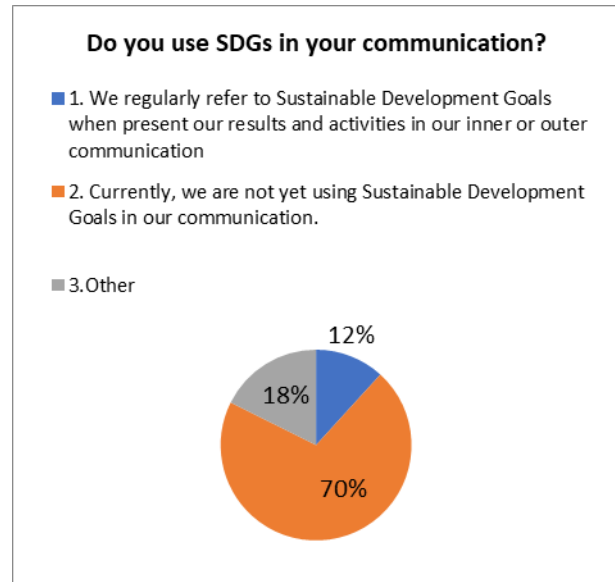


Figure 5-Communicating SDGs- Questionnaire

The web-content analysis found no community that used SDG to refer to their work. Four ecovillages web-content had general information on SDGs but did not refer to the communities' SDG-related work. While in 13 ecovillages, we did not find any publications mentioning the UN SDGs (*Figure 4*). The same question was asked in the questionnaire. *Figure 5* shows only a few ecovillages who claimed to refer to the SDGs when communicating their activities and achievements

As a final step, we compared the results of the web-content analysis with the ecovillages' self-assessment and classified the studied ecovillages into five SDG relation categories (*Figure 6*). None of the studied ecovillages fall into the category of "Uses SDGs to refer to the ICs work and aims".

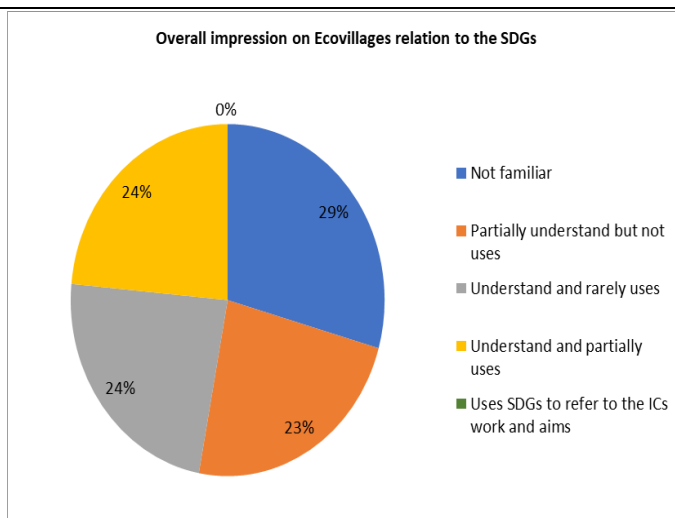


Figure 5. Overall impression on ecovillages SDGs relation

The overall impression was that while each ecovillage does outstanding work for SDGs’, only a few are aware of it. Their answers suggest that SDGs are not known, used and valued as a framework for communicating their aims and achievements. Most ecovillages do not see SDGs as a potential tool to collaborate for common goals; they see it as an empty signifier used by the mainstream regime. A survey with 20 members of Hungarian ecovillages examined if SDG attitude can be shifted.

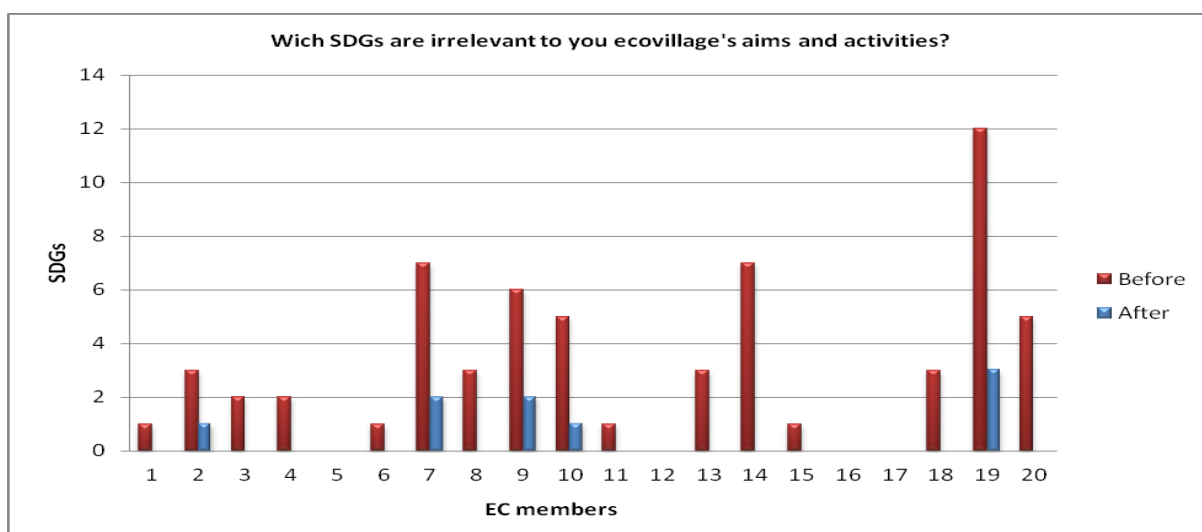


Figure 6. Change in owning the SDGs attitude before and after the SDG6 localizing workshop

Representatives indicated the relevant SDGs to their communities’ aims and activities before and after an SDG6 Localizing Workshop. This workshop filled up the SDG 6 targets with local context in a participatory manner. The difference was striking, as before the workshop, only a few SDGs, but after the workshop, most SDGs were marked as relevant to the community’s aims and work (*Figure 7*). The number of SDGs perceived as irrelevant significantly reduced after the workshop.

DISCUSSION

The studied literature claims that Ecovillages, by their very nature, contribute to the achievement of SDGs. They have experimented with solutions that are worth upscaling in their local geographical and socio-cultural environment.

The web-content analysis of the 17 studied ecovillages proved that each community works for sustainability in its local environment. The studied ecovillages' aims and works were set without knowing the SDGs; still, their activities correspond and contribute to most SDGs' local and global achievement. Our research confirmed that ecovillages inherently serve to achieve SDGs by their very nature.

We found significant differences between the web-content analysis and the ecovillages' self-assessment regarding the SDGs. In most cases, the web-content analysis result was not in match with the self-assessment results. IC representatives tended to identify more SDGs irrelevant to their aims and activities than their web content showed. From the ecovillages' online communication, we can see that the communities' activities are linked to the SDGs. Still, they do not express their achievements and actions in SDGs on their online platforms. The research results suggest that many ecovillages do not perceive the intended meaning of SDGs. A possible interpretation of this phenomenon could be that the studied ecovillages perceived SDGs as empty signifiers. Our research showed that their perception changed when SDGs were identified and filled with their local contexts.

Ecovillages could play an essential role in the regional and global SDG work if their SDG relevance is known and communicated. The studied ecovillages contribute to the achievements of the SDGs but are unaware of the SDGs relevance to their aims and activities. Awareness-raising is needed to draw attention from the ecovillages, and local and global stakeholders on the importance and potential role of ecovillages in achieving the SDGs.

ACKNOWLEDGMENT

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**COMPARISON BETWEEN GERMINATING PARAMETERS OF BASILS
(*OCIMUM BASILICUM* L.) AND PUMPKIN (*CUCURBITA PEPO* L.) UNDER
DROUGHT STRESS CONDITIONS.**

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ABSTRACT

Drought stress is becoming an intimidating obstacle to global agriculture in the 21st century, creating major food security challenges. Drought-sensitive crops, in particular, to which pumpkin and basil belong, reduce yield potentials. Lack of water can inhibit germination of sown seeds and manipulate germination parameters. An experiment was conducted to investigate the effect of drought stress, induced by (polyethylene glycol) (PEG), on some germination parameters (germination percentage, germination energy, germination rate index, mean germination time and root elongation) of pumpkin (*Cucurbita pepo* L.) and basil (*Ocimum basilicum* L.). The PEG concentration in both species was (2.5%) along with a control treatment (nutrient solution), on both species in three replicates of every treatment. Germinated seeds were counted every day at the same time, and the daily associated root elongation was measured by using a regular ruler. Each stage was considered finished when the average hypocotyl of the control treatment reached 3 cm long. Pumpkin took nearly 7 days to reach maximum root elongation, whereas basil took 8 days but failed to reach around 1.5cm root length and died. The results showed that basil seeds were extremely sensitive to water deprivation and could not germinate in 2.5% PEG solution, whereas pumpkin seeds germinated well in 2.5% PEG solution. It was found that the PEG treatment reduced germination by 25% in the case of pumpkin, whereas basil could not germinate well and the PEG treatment reduced germination by 75%. It demonstrates that pumpkins can withstand drought stress better than basil.

Keywords: Drought stress; germination; polyethylene glycol; pumpkin; basil.

INTRODUCTION

Climate change will inevitably show its consequences all over the globe as a result of global warming. Temperature rises and shifting weather patterns are likely to exacerbate already-existing water shortages in certain areas. The incidence and intensity of droughts and floods is estimated to adjust, which can lead to a severe death and property loss across Europe (ÖZDEN ET AL., 2008).

Drought is one of the most serious environmental stresses, limiting crop yields in many parts of the world, especially in hot and dry regions. (PORUDAD AND BEG, 2003). Precipitation and water scarcity are the first thoughts that come to mind when drought is discussed. (KULAÇ ET AL., 2010). Drought, which is deteriorating by the day, and thirst as a result of it, have devastating consequences in green fields, as well as in other aspects of our lives. Roots are the first organ in plants to detect drought stress (DAVIES ET AL., 2002; WILKINSON AND DAVIES, 2002), and as a result, plants can form fine roots that can invade smaller soil pores and increase water absorption to some degree (OH AND KOMATSU, 2015; KOMATSU AND HOSSAIN, 2013).

Various methods are used to identify species' drought resistances. One of these methods is to apply polyethylene glycol PEG to the seed's nutrient solution in various concentrations. PEG applications have been used in many species to identify drought resistance, with very positive results (BAHRAMI ET AL., 2012; MUJTABA ET AL., 2007).

Pumpkin seeds are used for the curing of various illnesses, and the herbal drugs are used for medicinal care individually or combined. The pumpkin is the famous food plant used to cure various food illnesses and phytochemical compounds (YADAV ET AL., 2010). Despite these facts, it is considered as drought tolerant crop (SEYMEN ET AL., 2019).

Sweet basil is known as a crucial fresh vegetable and a different medicinal herb. Basil plants include antibacterial, antioxidant, antimicrobial, anti-inflammatory and several other positive consequences for consumer health based on previous study findings (TANRIKULU ET AL., 2018; JULIANI ET AL., 2002). The aim of this experiment was to investigate the effects of artificial of (in laboratory drought stress caused by PEG on germination parameters of Pumpkin and Basil. In this research, the water stress resistance of pumpkin and basil was also identified.

MATERIALS AND METHODS

The experiment was performed at the Debrecen University Institute of Crop Sciences in 2021. Two distinct species were used to compare germination parameters: Pumpkin (*Curcubita pepo* L') (120 seeds) and Basil (*Oscimum basilicum* L') (120 seeds).

Pumpkin and basil seeds were hand-selected based on standardized seeds size that were surface sterilized with 6% (v/v) H₂O₂ for 20 minutes, then rinsed four times with distilled water and germinated geotropically between moisten filter papers at 22°C. The control medium was the nutrient solution (NS) medium (with the addition of the required amount of sterile distilled water). The nutrient solution consisted of the following components: 2.0 mM Ca(NO₃)₂·4H₂O, 0.7 mM K₂SO₄, 0.5 mM MgSO₄·7H₂O, 0.1 mM KH₂PO₄, 0.1 mM KCl, 0.5 μM MnSO₄·4H₂O, 0.5 μM ZnSO₄·7H₂O, 0.2 μM CuSO₄·5H₂O and 0.1 μM H₃BO₃. Iron was provided in the form of 104 M Fe-EDTA. Polyethylene glycol (6000 PEG) (VWR International bvba Geldenaaksebaan, Leuven, Belgium) was used at a concentration of 2.5 % to induce water stress. In case of pumpkin, 20 disinfected seeds were placed on each roll for each treatment, and experiments were carried out in triplicate while 20 sterilized seeds on each roll in case of basils in 3 replications. Seed germination was monitored for 7 days and the parameters of germination were assessed accordingly. Seeds were considered germinated when the radicle had protruded 2 mm across the coat of the seed. Each stage was declared complete when the average hypocotyl of the control treatment reached 3 cm in length.

Six different germination parameters were assessed. The methodology of calculations of parameters 1, 2, 3 and 4 followed (AL-MUDARIS, 1998), parameter 5 followed (AOSA, 1983), parameter 6 followed (CZABATOR, 1962).

1. Final germination percentage (G) = the total seeds germinated at end of trial/number of initial seeds used 100 times.
2. Mean germination time (MGT) = $\Sigma Fx/\Sigma F$; where F is the number of seeds germinated on day x.
3. Germination index (GI) = $G1/1+G2/2+.... +Gi/i$; where G1 is the germination percentage on day 1, G2 is the germination percentage at day 2; and so on.
4. Coefficient of velocity of germination (CVG) = $N1+N2+...+Ni/100 \times N1T1+...+NiTi$; where N is the number of seeds germinated every day and T is the number of days from seeding corresponding to N.
5. Seed Vigor Index (SVI)= [(mean root length + mean shoot length) × %germination]
6. Speed of germination (GS)= $\Sigma(ni/ti)$

At the end of the study, the effect of PEG application on the germination percentage, mean germination time, coefficient of velocity of germination, germination index, speed of germination and seed vigor index were analyzed using the Sigma plot program. For statistical analysis Sigma Plot 14 for Windows (Systat Software) was used. During the data analysis, one-way ANOVA method was used.

RESULTS

The results of the mean value, \pm standard error are given in Table 1. There was a statistically significant difference between control (NS) and polyethylene glycol (PEG) with regards to all germination parameters studied (*Table 1*). Based on the results of germination parameters, we found a significant difference between the pumpkin and basil as recorded (*Table 1*). Drought stress affected the root length of basil seeds more than pumpkin seeds, according to the results of the germination parameters. Drought-stressed pumpkin seeds had higher values for the number of roots and root length as compared to basil. In case of pumpkin, GP of control (NS) was (91.6 ± 1.666) , but only (83.3 ± 1.666) under drought stress conditions. Comparing between pumpkin and basil values of GP were (63.3 ± 1.66) and (50 ± 2.88) in control and PEG treatment respectively. Basil was (13%) under drought stress. The study's analysis indicated the impact of drought stress on basil germination characteristics. The MGT of basil was significantly greater than that of pumpkins. It indicates that pumpkin seeds could germinate faster than basil. MGT of pumpkin seeds was reduced by 12.6 % compared to basil under PEG (*Figure 1.b*).

The lowest germination index (GI) was obtained in the stressed group in the case of pumpkin and basil rather than the control group, even when the values between pumpkin and basil are compared (*Table 1*). The GI value of basil was significantly lower by 20% in the control. Under PEG conditions, the value of basil was significantly reduced by 40.6%. This shows that the 2.5 % concentration of PEG had no influence on the germination properties of pumpkin, but had a deleterious impact on basil.

There was a significant difference in the co-efficient of germination velocity between pumpkin and basil when they were subjected to water stress. When treated with PEG, the average coefficient of germination velocity for pumpkin was (22.658±0.445) and for basil was (19.656±1.111). It was clearly found that pumpkin had a substantially greater SVI value than basils. In pumpkin, the difference between the two treatments was 27.7%. Basils, on the other hand, had (75.7%) difference. Pumpkins had a substantially higher germination speed (GS) than basils; under non-stressed conditions, GS was (2.714±0.0824) and (1.761±0.047) for pumpkin and basils, respectively. Under stressful conditions, the value of pumpkin and basils was (2.333±0.047) and (1.4761±0.095), respectively.

Table 1. Values of the germination parameters (Germination percentage GP%, mean germination time MGT; day, germination Index GI; day, co-efficient of germination velocity CVG; seeds day⁻¹, seed vigor index SVI; day, and germination speed GS; day) of Pumpkin (*Cucurbita pepo* L) and Basil (*Ocimum basilicum* L) under control (NS) and PEG (drought stress), (n=3, ±s.e.)

		G%	MGT(day)	GI (day)	CVG(seeds day ⁻¹)	SVI (day)	GS(day)
Basils	CONTROL	63.3±1.66	4.30±0.16	4.32±0.15	23.62±0.546	206.6±7.85	1.76±0.047
	PEG	50±2.88	5.05±0.33	2.43±0.41	19.65±1.111	50.6±3.614	1.48±0.095
Pumpkin	CONTROL	91.6±1.666	3.49±0.179	5.51± 0.12	28.78±1.445	414.0±2.76	2.71±0.082
	PEG	83.3±1.66	4.41±0.085	4.18±0.242	22.6±0.445	299.3±5.04	2.33±0.05

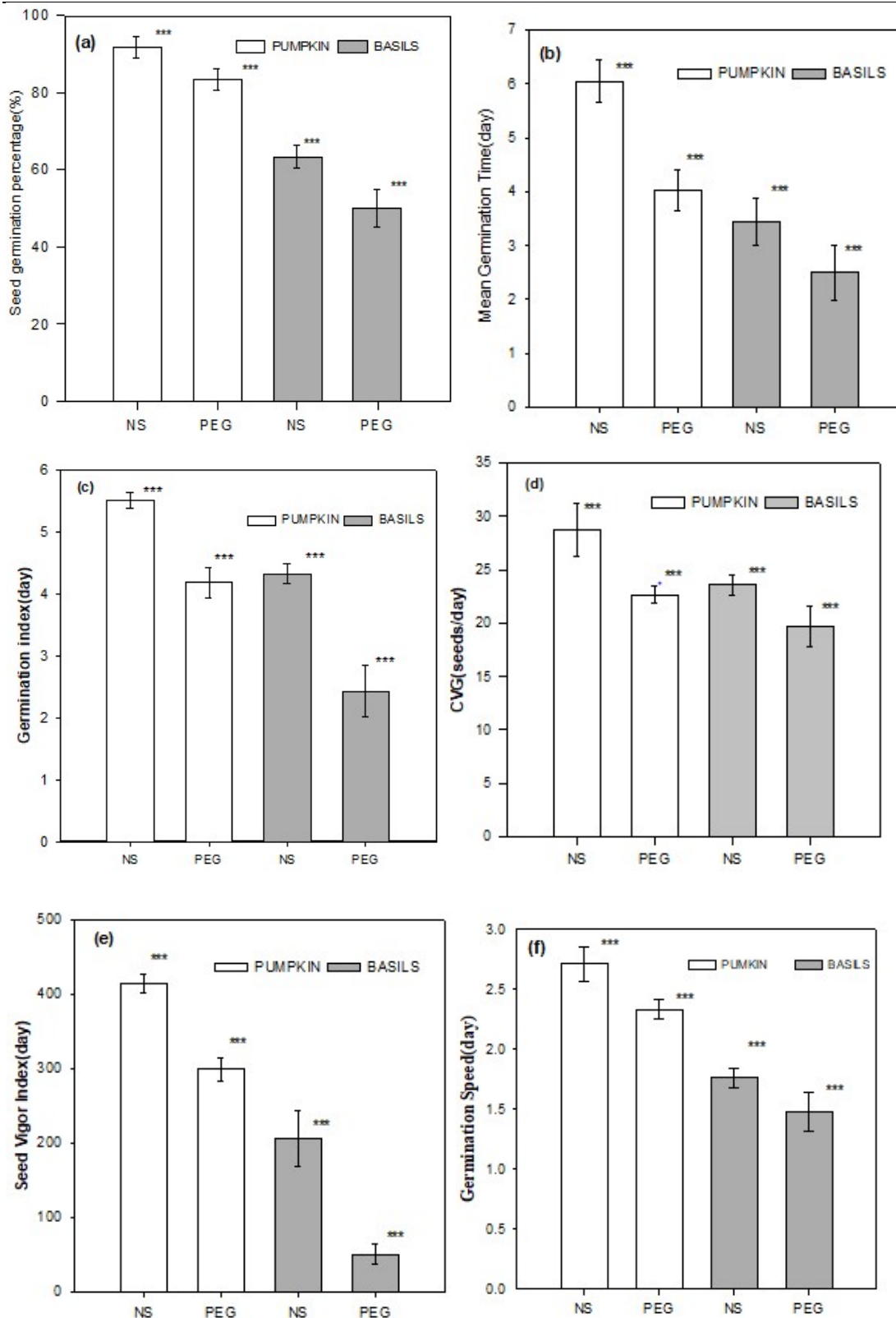


Figure.1 Germination parameters of pumpkin and basil under control (no-drought) and 2.5% PEG (drought stress) condition: (a) Germination percentage, (b) Mean Germination Time, (c) Germination index, (d) Coefficient of velocity of germination, (e) Seed vigor index, (f) Germination speed, (n=3, \pm s.e.), Significant differences were signed***($p \leq 0.001$).

DISCUSSION

Drought stress has been the subject of several research. Despite the fact that pumpkins can withstand drought (MUSA SEYMEN ET AL., 2019). All of the germination parameters for pumpkin and basil have been determined. Because PEG had a higher influence on basil root length and morphological and physiological characteristics, it was determined that basils are drought sensitive. It has been demonstrated by (ALI REZA ET AL., 2014). We discovered a substantial difference in the germination percentage of basils and pumpkins in this study. The pumpkin and basil germination rate was 83.3% and 50.3% respectively under PEG condition. Water deprivation has been found to affect all basil germination parameters more than pumpkin. The germination parameters of basils have been considerably affected by the water shortage. Compared with basil, we found no change in the pumpkin germination parameters.

CONCLUSION

In conclusion, while pumpkin seeds germination percentage was higher under relative drought stress conditions. Germinated Basil seeds showed zero 'tolerance; the roots were unable to go deeper in order to meet more potential water levels. The root length had a notable impact on germination parameters, and it would most likely affect the plant's future growth, which will be very important to examine in order to understand the potential consequences of drought stress on the physiological traits during the later vegetative and reproductive periods of the Basils

ACKNOWLEDGEMENT

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BUSINESS IMAGE AND STRATEGIES IN ROMANIAN AGRITOURISM

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ABSTRACT

Business image is a paramount when it comes to improve a company's desirability as a borrower, client, customer, employer, supplier, etc. The most important strategies to build up business image are creating a website, creating straightforward, easy-to-understand pricing, designing the business image, doing a referral exchange, encouraging personal recommendations, listing creatively and widely, maintaining a customer database, maintaining good employee relations, making a marketing plan, making the business look good, naming and branding, and using the press. The paper presents the most important strategies illustrated by three Romanian agritourism guesthouses.

Keywords: business, image, strategies, communication, agritourism

INTRODUCTION

Business dictionaries define business / corporate / organisation image as a "Mental picture that springs up at the mention of a firm's name. [...] a composite psychological impression that continually changes with the firm's circumstances, media coverage, performance, pronouncements, etc. [...] the public perception of the firm rather than a reflection of its actual state or position." (BUSINESS DICTIONARY,) It is similar to a firm's goodwill or reputation. It differs from corporate identity because "it is fluid and can change overnight from positive to negative to neutral" (BUSINESS DICTIONARY).

Companies use various corporate advertising techniques to enhance their image in order to improve their desirability as a borrower, customer, employer, supplier, etc.

Strategy is defined by business dictionaries as "1. A method or plan chosen to bring about a desired future, such as achievement of a goal or solution to a problem. 2. The art and science of planning and marshalling resources for their most efficient and effective use." (BUSINESS DICTIONARY).

Corporate / organisational image can be defined from two different perspectives (DUTTON, DUKERICH & HARQUAIL, 1994):

- As perceptions of internal members, a "communicated image", a "construed external image", a descriptive view referring to how insiders believe external audiences view their organization (GIOIA, SCHULTZ & CORLEY, 2000);
- As perceptions of external members, a "projective view", "outsiders' beliefs about what distinguishes an organization" (DUTTON, DUKERICH, & HARQUAIL, 1994, 243), encompassing the "characteristics organizational elites want stakeholders to ascribe to the firm" and (GIOIA & THOMAS, 1996, IN MASSEY, 2003) (see also DI MARINO, 2008).

Corporate image needs developing and managing for the following reasons (ADENIJI et al., 2013):

-
- Creating good identity for the employees, thus leading to their satisfaction;
 - Enhancing corporate competitive advantage, thus leading to higher profitability;
 - Establishing a corporate goodwill for the organisation;
 - Influencing investors and financial institutions;
 - Promoting favourable relationship with the community in the environment the organisation operates to avoid difficulty in recruitment, selection and maintaining the employee morale;
 - Promoting good relationship with the government, opinion leaders and various interest groups;
 - Stimulating sales, thus influencing customer loyalty.

MATERIALS AND METHODS

The research methods consisted in consulting a specialized literature on the marketing communications mix in agritourism, books, websites, and comparative analysis.

Nevertheless, the research method is a descriptive one: it “seeks to describe a situation, and more precisely, when it comes to marketing, to describe a marketing mix” (MISHRA, 2008, IN JOLY & TOUS, 2012). The analysis has been done based on websites advertising for guesthouses practicing agritourism in rural Romania (Casa Wia Rusti, Braşov County, <https://wiarusti.ro>; La Roata, Suceava County, <https://www.la-roata.ro>; and Manoir Mignon, a four-star hotel B&B in Suceava County).

RESULTS

After studying the literature on the building up strategies for business / corporate / organisation image, twelve strategies have come out repeatedly (YOUR BUSINESS IMAGE: TEN WAYS TO BUILD AND MARKET IT).

1. Creating a website. In the era of ICTs, a website is a must: if a business does not have a website, it does not exist for the business environment. A good website has a professional look and feel that suits the business. There are several advantages of having a website for one's business:

- It allows advertising through Facebook ads, SEO (Search Engine Optimisation) service provider, etc.;
- It can be attractive with a blog page to post fresh content;
- It can be extremely valuable due to its links;
- It can help build better relationships with the customers (the company sends messages to its customers, and the customers send feedback to the company);
- It can help ensure long-term customers;
- It can help generate more customers outside the business' city and worldwide;
- It can help increase sales by consistently updating and promoting its content;
- It gives the business the opportunity to prove its credibility;
- It is accessible 24/7;
- It is less expensive (sometimes even free of charge) than the printed media, radio, TV, etc.;
- It is more convenient for customers and leads;
- It provides information on what happens on it (number of visitors, messages, and e-mails; updates; website progress).

The website page dedicated to agritourism in Romania (AGROTURISMUL ÎN ROMÂNIA) presents three guesthouses in the rural area (Casa Wia Rusti, Braşov County; La Roata,

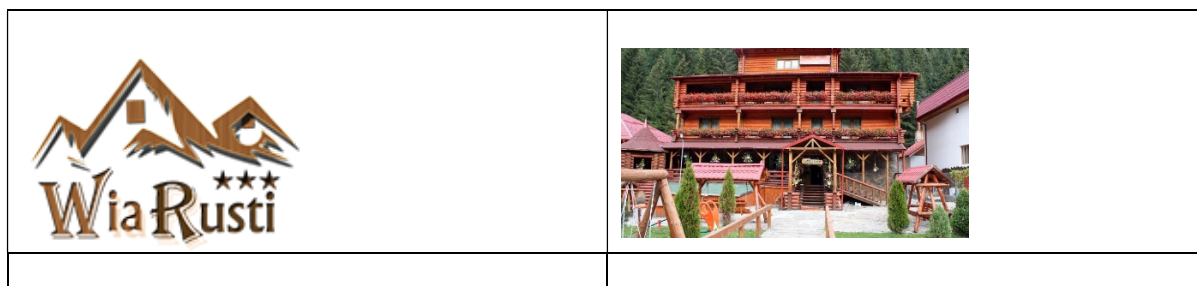
Suceava County; and Manoir Mignon, Suceava County), all of which have their own website with minimum information about accommodation food, or attractions.

2. Creating Straightforward, Easy-To-Understand Pricing. Price strategies are impacted by corporate image, discounts, geography, price discrimination, price sensitivity. External corporate image affects its ability of adopting a specific price strategy (for instance, a mid-market supermarket chain would find it difficult to move up market in price; a low-cost automobiles producer would find it extremely difficult to move up to an image of luxury cars producer) (SAMMUT-BONNICI & CHANNON, 2015). Pricing strategies (such as bundle pricing, captive pricing, economy pricing, geographical pricing, price skimming, pricing at a premium, pricing for market penetration, promotional pricing, psychological pricing, and value pricing – cf. SCOTT, 2019) should take into account – besides account segments, competitors' actions, consumers' ability to pay, distribution costs, input costs, market conditions, production costs, trade margins, and variable costs (SCOTT, 2019) – Internet pricing disparity, manufacturers selling costs and trade allowances, price optimization modelling, and retail consolidation. On the other hand, pricing strategies have a considerable impact on consumer pressure groups, government agencies, regulatory authorities, shareholders, etc. Many businesses use complicated pricing structures and try to hide their prices from their customers. Or, service businesses, for example, should streamline and make their pricing clear (i.e., tell the customers exactly how much they should expect to pay for every particular service with the help of a pricing menu).

The website of Casa Wia Rusti supplies information about the price for the three types of accommodation provided (twin room, triple room, and suite) except for a substantial accommodation discount for those who opt for a private tour, but no detail about the price for food, except the mention that they can cater for orders above 100 Ron. The website of Manoir Mignon supplies information about the tariffs in Euros for each type of accommodation (single room, twin room, suite jr., and suite), and offers a discount of 12% or minimum two nights or tourist groups of eight people. The website of La Roata Guesthouse supplies no details regarding the price of accommodation or food, but mentions that holiday vouchers (paper or card) are accepted!

3. Designing the Business Image. Graphic design concerns the overall visual presentation of the organisation, i.e., “visual identification” (GRAY & BALMER, 1998): design style of the company's literature, signs and stationery; number of logos; style of the colouring, illustrations, layout, photography, typeface, and type of logos. Among these visual identification elements, the logo is the heart of the corporate graphics design system: it can be changed over time to reflect the evolving, modernising corporate identity. A company's visual presentation may not always appropriately communicate its identity.

This is the image (logos & photos) of the three studied guesthouses (*Figure 1*).



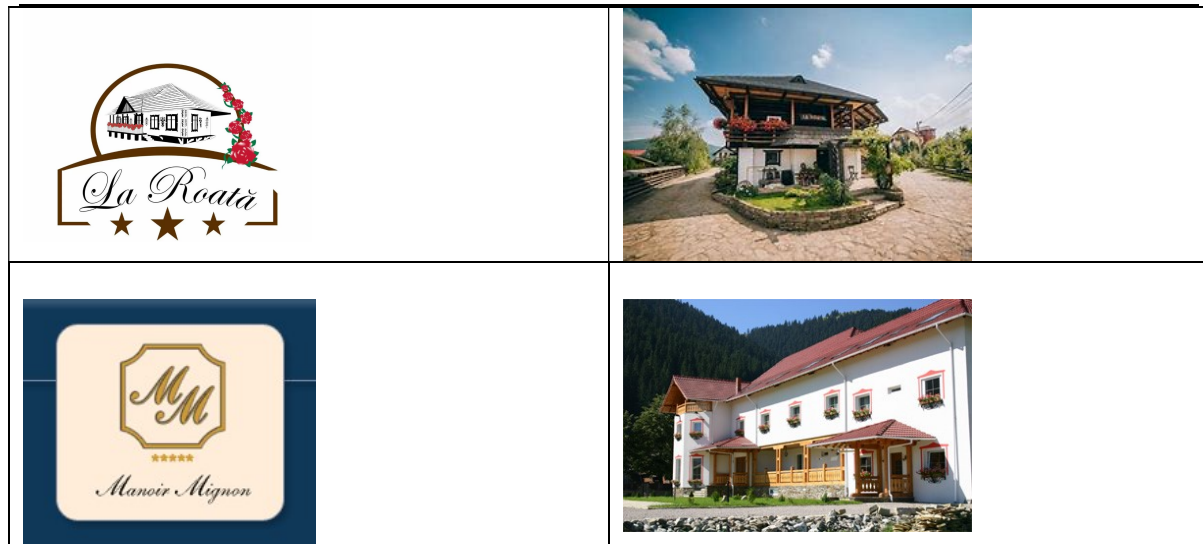


Figure 1. Guesthouses Casa Wia Rusti, La Roata, Manoir Mignon image (sources: <https://wiarusti.ro>, <https://www.la-roata.ro>, www.manoirmignon.ro)

4. Doing a Referral Exchange. Two related business (e.g., chiropractors and massage therapists, dentists and orthodontists, financial planners and tax preparers) may refer clients to each other. In this case, they should set up an exchange by:

- Placing brochures / cards at the second business's office / store;
- Displaying the other business's marketing materials in the first business's place of business.

This strategy seems to be unidirectional. Thus, the website of Casa Wia Rusti shows no sign of referral exchange, but it mentions that the guesthouse is 10 km, far from the famous Bran Castle (however, Booking.com makes more references about the attractions of the area – Dino Parc, George Enescu Memorial House, Știrbey Castle). In exchange, the website of La Roata has a “Tourist Attractions” button suggesting leisure places (a ski slope, a swimming pool), local attractions (Suceava Fortress, Folk Crafts Museum), and monasteries (Gura Humorului, Moldovița, Sucevița, Voroneț) to visit during the stay. The website of Manoir Mignon suggests visiting the painted monasteries of Bucovina, the monasteries of Neamț County, and the wooden churches of Maramureș County.

5. Encouraging Personal Recommendations (referring a friend may get the business points, a 50% cut for a haircut, etc.) may be the best way to get new customers because almost nothing is more powerful than an endorsement from a friend / relative and it is free.

Business referral may be done by:

- Amplifying the business product giveaways with social media;
- Building up the excitement;
- Establishing the business’s authority with free webinars;
- Giving away awesome stuff;
- Helping an NGO do something good;
- Offering a taste with free premium access;
- Paying referrers for each referral;
- Rewarding referrers in credits;
- Rewarding referrers with the business’s best stuff;
- Showing love with gift cards.

None of the three guesthouses seems to encourage personal recommendations.

6. Listing Creatively and Widely is a great way to draw people to the business, and it is usually low-cost / free. Listing should be done:

- In not-so-obvious places (an NGO listing of businesses with good environmental and social practices, a website where parents make referrals about services for their children);
- In obvious places (Chamber of Commerce, Yellow Pages).

Casa Wia Rusti is listed on Booking.com (rating: 9.3 out of 10) and TripAdvisor (rating: 3.5 out of 5), and on Romanian tourism / travel websites (Direct Booking.ro, portal-info.ro, TURIST INFO.ro, etc.), and is also present on Facebook. La Roata is listed on Airbnb, Booking.com (rating: 9.6 out of 10), TripAdvisor (rating: 4.5 out of 5), Vrbo, and on Romanian tourism / travel websites (Discover Eco Romania), and is also present on Facebook and YouTube. Manoir Mignon is listed on TripAdvisor (rating: 3.5 out of 5) and on Romanian tourism / travel websites (cazarelapensiune.ro, Direct Booking.ro, pensiunidetop.ro, etc.).

7. Maintaining a Customer Database. A customer who used a business once and who had a good experience will be likely to use it again. It is less expensive to direct mail or e-mail promotions to customers in a customer database than to acquire a new customer. A complete customer's contact information should include: customer name, company name, work function, address, telephone, e-mail address, compiled address, estimated sale, last contact, lead status, lead source, product, and price per product unit (CUSTOMER RELATIONSHIP MANAGEMENT, 2013).

There is no data available on possible customer databases of any of the three guesthouses studied.

8. Maintaining Good Employee Relations. Employees who love their jobs and believe in the business they work for (because they are treated right): display / use / wear the business's merchandise or services and recommend the business to their families / friends. According to GRAY & BALMER (1998), "[...] employees should be trained and motivated to project a positive image of the organisation", particularly in the case of service organisations (because, in this case, personal interactions are the key to customer satisfaction). Improving a business's employee relations involves (Strategies to Improve Employee Relations):

- Assigning individuals targets and asking all team members to contribute equally and achieve the target within the desired time frame;
- Encouraging effective communication among the team members;
- Encouraging individuals to share their work with each other;
- Involving the team members;
- Organising morning meetings;
- Organizing birthday parties, Christmas parties, New Year parties etc. at the workplace;
- Praising the individuals if they have done something exceptionally well;
- Rewarding the individuals if they have done something exceptionally well;
- Trying one's level best that all the employees must have their lunch together at the same time;
- Writing modes of communication must be promoted among the employees for better transparency.

There is no data available on maintaining good employee relations of any of the three guesthouses studied but, given that they are all family businesses, this does not seem to be an issue.

9. Making a Marketing Plan. A formal marketing plan should:

- Check back regularly to track the business's progress;

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- Determine how and when specific performance goals will be met;
 - Include an analysis of the business's competitors;
 - Include an analysis of the business's market;
 - Include marketing ideas (on business marketing, press releases, referral program, website);
 - Include marketing objectives;
 - Outline the business's marketing budget;
 - Outline the business's mission;
 - Set specific performance goals.

Given that the three guesthouses have managed to be in business over the years, it seems that they all had good marketing plans.

10. Making the Business Look Good. A solid, strong physical impression making the business credible and inviting customers in may benefit, depending on the type of business, from a brochure, an office (tastefully decorated with business furniture and well-organized), a store front, a veterinary's practice (a whimsical design with bright colours and fun murals on the wall), or a website. Depending on the cultural environment of a business, the interior layout of offices may suggest different things: in the case of a large open room with desks in full sight of each other – openness; a series of closed offices – lack of openness (GRAY & BALMER, 1998). As shown in Figure 1, all three guesthouses look good.

11. Naming and Branding. The names used to identify an organisation, its divisions and its products are extremely important. They can be changed over time to reflect the evolving, modernising corporate identity, just like the logos (GRAY & BALMER, 1998). In another order of ideas, organisations may operate under different names if they have a portfolio of unrelated businesses, or if their subsidiaries have distinct / better-known names than the parent organisation.

Figure 1 above shows the logos of the three guesthouses. To note that only the logos of guesthouses Casa Wia Rusti and La Roata suggest rurality.

12. Using the Press. In large corporations, media relations are managed by a PR department, while, in smaller companies, they are typically handled informally by senior management (GRAY & BALMER, 1998). In public relations, the publics are competitors, consumers, courts, financial institutions, general, government, interest groups, media, public employees, scientific community, shareholders, suppliers, etc. (SINGH & PANDEY, 2017). A simple press release on a newsworthy angle on the business (e.g., a business grand opening, a business "story", why the business's offer is different) sent to local publications may be inexpensive, but it is effective, particularly in case of unfavourable rumours and stories (AGYAPONG, TWUM-AMPOMAH & ACHEAMPONG, 2015). Other appropriate communication channels are open days, press conferences (weekly, monthly, quarterly, bi-annual), Short Messages Service (SMS) number, etc. (ANYANGO, 2006). Public relations are particularly important for corporate image in crisis situations (FERGUSON, WALLACE & CHANDLER, 2012).

There is no data available on using the press by any of the three guesthouses studied.

DISCUSSION

Of the twelve corporate image building-up strategies listed above, the ones used by the three agritourism guesthouses studied are: creating a website, designing the business image, doing a referral exchange, listing creatively and widely, making the business look good, and naming and branding. Pricing strategies as a strategy is not very transparent.

While making a marketing plan and using the press are not explicit strategies, but have implicit effects, there is no evidence whatsoever regarding such strategies as encouraging personal recommendations, maintaining a customer database, or maintaining good employee relations (though they might play an important role in the businesses investigated here).

It would be better for the corporate image of the agritourism guesthouses investigated above to insist on the local attractions because tourists need more than just a bed to sleep and a table to eat when practicing agritourism. Cultural tourism might add value to the holidays and differentiate an agritourism location from other similar ones.

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INFLUENCE OF FOLIAR FERTILIZATION ON YIELD AND GRAIN QUALITY OF CORN

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ABSTRACT

We examined the influence of foliar fertilization on the yield and grain quality of corn in 2018. The experiment was set in three replications, random blocks on the area of Tangazdaság Ltd. in Hódmezővásárhely. The soil of the experiment was meadow chernozem. We sprayed out three different foliar fertilizer products individually and combined with each other as well, so there were six treatments and the control to be examined. The year 2018 was not favourable for corn production. In 2018 the amount of precipitation in the vegetative period of corn was lower by 70.5 mm than the average. The monthly average temperature in the vegetative period of corn was higher by 4 °C than the average of several year. We evaluated the obtained data by single factor analysis of variance. We obtained 10.33 t/ha in control treatment, and with the foliar fertilization the yield ranged between 10.52-11.40 t/ha. The foliar fertilization products increased the yield of corn, but this difference was not significant. By the application of foliar fertilization, the crude protein and starch content of corn grain did not change significantly. Our scientific results showed, that the foliar fertilization has positive effect on the yield of corn and small effect on the examined grain quality parameters.

Keywords: corn, foliar fertilization, yield, crude protein content, starch content

INTRODUCTION

The genetical productivity of the newest corn hybrids is continuously growing. In order to utilize the potential productive capacity of hybrids as much as possible, the harmony of the agro-technical factors is necessary (Kovács and Sárvári, 2016).

The low average yield in corn production can be due to the fall-back of chemical fertilization; this is why the use of fertilizers must be increased in order to reach higher and more consistent amounts of crop (KOMAREK, 2007; SÁRVÁRI AND PEPÓ, 2014, PEPÓ, 2017; SÁRVÁRI, 2019; SÁRVÁRI ET AL., 2021).

Foliar fertilization is a highly efficient crop fertilization method since it favours the assimilation of the nutrients in the plant and consequently, the utilization of the nutrients applied with the fertilizer, thus increasing crop yields and quality (TEJADA AND GONZALEZ, 2004; ABBAS AND ALI, 2011; OSMAN ET AL., 2013).

In practice, foliar fertilizers are able to meet only a few percent of the main macroelement demands of plants. Foliar fertilization cannot provide nutrient uptake through the soil, just supplements it. The foliar fertilizer can get directly to the place of use, the leaf cells and can act immediately without the mediation of the soil. Nutrient uptake can be sustained even in drought, with little water. Under ideal conditions, the nutrient utilisation might reach 100% (KÁDÁR, 2002).

According to KÁDÁR (2008), the future spread of foliar fertilization must be grounded by comprehensive experimental research. Accurate, repeated small plot trials are necessary to clarify the factors influencing the effectiveness of foliar fertilizers and recommendations must be developed for consultation.

Nowadays, in order to achieve high yields, cultivated plants cannot always get enough microelements from the soil, therefore the importance of foliar fertilization increased. The timing is decisive for rapid and effective intervention to prevent yield loss or deterioration, and we can achieve yield increase and quality improvement as well. With the application of foliar fertilization, we can increase the resistance of corn against the ecological stress factors, diseases and pests as well (HOFFMANN ET AL., 2014).

Foliar fertilization had good effect in corn production on meadow chernozem soil, which contains a lot of phosphorus and a few amounts of Zn. The foliar fertilization products can decrease the yield fluctuation, and increase the yield amount. (JAKAB ET AL., 2014a; JAKAB ET AL., 2014b; JAKAB ET AL., 2016a; JAKAB ET AL., 2016b; JAKAB ET AL., 2016c; ZOLTÁN AND JAKAB, 2016; JAKAB AND KOMAREK, 2017).

MATERIALS AND METHODS

Soil properties of the experimental field

The research work has been carried out the experiment on the area of at the SZTE Tangazdaság Ltd. in Hódmezővásárhely. The soil was meadow chernozem, the reaction of which was nearly neutral (pH_{KCL} 7.17). Before setting the experiment, the soil analysis data showed that it had good nitrogen and very good phosphorus and potassium contents. The nitrogen content was determined based on the humus content. The Zn content was low (*Table 1*).

Table 1. Main properties of the experimental area

pH (KCL)	P ₂ O ₅ (mg/kg)	K ₂ O (mg/kg)	Humus (%)	Soil plasticity value (K _A)	Zn (mg/kg)
7.17	336	620	3.39	48	1.76

Weather in the experimental year

The year 2018 was not favourable for corn production. In 2018, the amount of precipitation in the vegetative period of corn was lower by 70.5 mm than the average (*Table 2*). The average temperature showed a positive deviation compared to the average of several years. The positive deviation of average temperature together with deficient precipitation had a negative effect on the development of corn, which resulted medium yields.

Table 2. The amount of rainfall in the vegetative period of corn in 2018

Month	Rainfall (mm)	50 years average rainfall (mm)	Difference (mm)
April	12.4	39.9	-27.5
May	53.9	58	-4.1
June	85.2	75.3	9.9
July	51.4	58.7	-7.3
August	31.4	48.7	-17.3

September	16.5	40.7	-24.2
Total amount of rainfall (mm)	250.8	321.3	-70.5

Main features of the agrotechnology applied

The small plot experiment was set in three replications, organised as a random block. The size of each plot was 15 m². The forecrop was winter wheat. Fall tillage involved deep ploughing at 30 cm depth in the experimental year. The sowing date was on 24th of April. Plant density was 70.000/ha. The examined hybrid was DKC 4943 (FAO 390-410).

Foliar fertilization was applied once in 6-7 leaves stage of plants with a dose suggested by the manufacturers. The foliar fertilizers were put out with back-pack-sprayers. The applied products were the following:

- Algafix (microbiological biostimulator, that contains live algae which produce cytokinin, a plant hormone to help the shoot-growth of the plant),
- Amalgerol (product containing alga extract, plant extracts, plant essential oils and mineral oils), and
- Fitohorm Turbo Zn solution (containing Zn, the most important microelement for corn)

We applied these three products individually and combined with each other as well, so there were six treatments and the control plot. Apart from foliar fertilization, the parcels received the same agrotechnology We harvested the plots by hand. The protein and starch content were determined with Mininfra 2000 device. We evaluated the obtained data by single factor analysis of variance.

RESULTS

The yield of the control treatment was 10.33 t/ha. With the application of foliar fertilization the yield varied between 10.52-11.40 t/ha. The foliar fertilization treatments increased the corn yield compared to the control, but it was not significant. We obtained the highest yield in the Algafix treatment (11.40 t/ha). We got high yield in Algafix + Fitohorm Turbo Zn (11.23 t/ha) and Amalgerol + Fitohorm Turbo Zn (11.35) treatments (*Figure 1*).

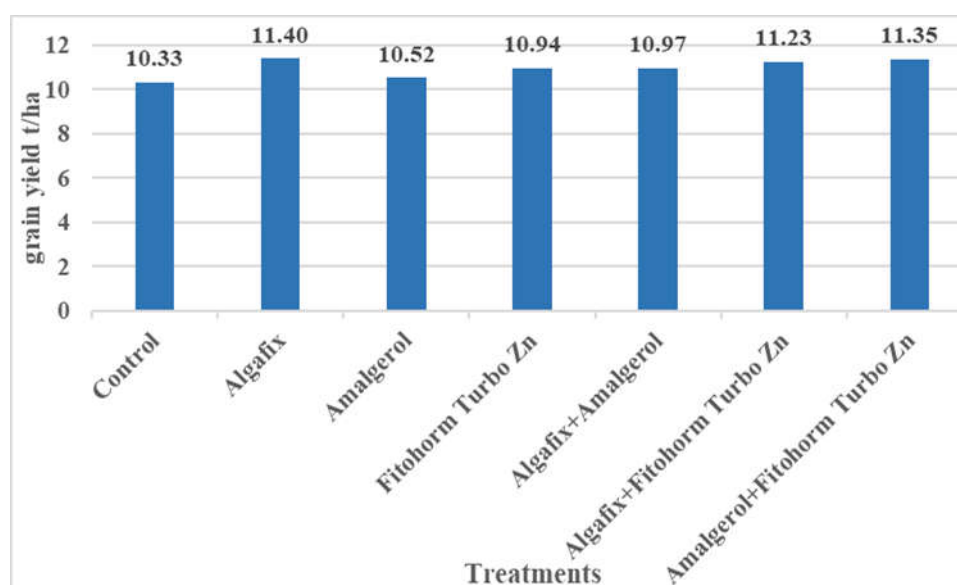


Figure 1. The yield of corn in control and different foliar fertilization treatments

We examined the effect of foliar fertilization on some quality parameters of corn grain (protein and starch content).

The protein content of corn grain is relatively low (under 10%). The grain protein content of control treatment was 7.8%. Under the influence of foliar fertilization the protein content varied between 7.22-7.82%. The maximum value of grain protein content was 7.82% in Algafix treatment.

Starch is in the highest amount in corn grain. The starch content of corn grain varied between 71.93-72.27%. The starch content in control treatment was 71.93%. The maximum value was 72.27% in Algafix+Fitohorm Turbo Zn treatment. The protein and starch content of corn grain did not change significantly (*Table 3*).

Table 3. The values of corn grain protein and starch content in different foliar fertilizer treatments

Treatments	Protein content (%)	Starch content (%)
Control	7.80	71.93
Algafix	7.82	71.93
Amalgerol	7.43	72.00
Fitohorm Turbo Zn	7.74	71.83
Algafix+Amalgerol	7.57	71.90
Algafix+Fitohorm Turbo Zn	7.22	72.27
Amalgerol+Fitohorm Turbo Zn	7.65	71.67
	N.S.	N.S.

DISCUSSION

We examined the effect of different foliar fertilizer products and their combination on the yield as well as protein and starch content of corn grain in 2018. The yield of the control treatment was 10.33 t/ha. Compared to that, higher yields were measured in all treatments. The yield increase compared to the control, was not significant in either case. The foliar fertilizers applied individually resulted in 0.19 to 1.07 t/ha surplus yield compared to the untreated parcel. The highest yield increase was achieved by Algafix treatment (1.07 t/ha). When the products were applied in combination, there was 0.64 to 1.02 t/ha surplus yield compared to the untreated parcel. The highest yield increase (1.02 t/ha) was measured in the treatments with Amalgerol+Fitohorm Turbo Zn.

The results of our studies are the same as those published by TEJADA ET AL. (2018) who also found that foliar fertilization increased the corn yield. The foliar fertilizer products had minimal effect on the protein and starch content of corn grain.

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Mosonmagyaróvár: Széchenyi István Egyetem Mezőgazdaság- és Élelmiszertudományi Kar, 2016. 246-251.(ISBN:978-615-5391-79-8)

THE CONNECTION BETWEEN STORAGE AND QUALITY OF MEADOW HAY**ANDRAS HALASZ* TIHAMER MARCSOK**

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*Corresponding author: halasz.andras@uni-mate.hu**ABSTRACT**

The practical application of hay quality is of particular importance in Hungarian beef cattle and horse farming. Due to the high price of protein and supplementary feeds on the international market, it may be a worthwhile alternative to base the demand for feedstuffs exclusively on high feed value meadow hay. To do this, it is necessary to be aware of the daily variation in quality and quantity. Following the good practice guidelines both livestock farming and product marketing can be planned. Our recommended solution is focusing on quality reservation. The presented technology (ventilation, dry floor, large air space) guarantee the conservation of the genuinely high value hay. Strict protocol must be applied (mowing at the right time with conditioner, forage sampling for digestible fibre content). After stacking, bale temperature increases during the first 5 days up to 41°C. Then the next 8 days a stagnant trend is seen. At the final stage, core temperature stabilizes at 30°C. Preventing caramelization and hay stack fires are priorities for every farmer.

Keywords: core temperature; hay storage; digestible fibre; rumen passage; stack fire

INTRODUCTION

When you hear the word hay, most farmers think of alfalfa hay. That's probably because alfalfa hay is our best-known, most commonly produced legume crop. According to the National Statistics (NET 1), 200 000 hectares were under alfalfa cultivation in 2019. It is easy to incorporate into crop rotation and can be counted as an ecological focus area as a nitrogen-fixing crop as part of compulsory greening. If the farmer uses certified seed and applies the prescribed amount of seed when sowing, he is also entitled to an additional fibre protein crop premium. For alfalfa, the average yield is 5 T ha⁻¹, while for grassland it is 1-2 T ha⁻¹ in dry, arid areas. Its production and harvesting require a complex technological line, but it has a marketable price range, even on export (HALASZ, 2020). No question about protein side nutritional value of alfalfa hay but the digestible fibre and mineral content of grass is more nuanced (*Table 1*).

Table 1: Comparison of nutrient content of hay and alfalfa (BUCHGRABER ET AL., 1998)

	Alfalfa	Meadow hay
Protein (g/kg)	224	115
Fat (g/kg)	18	22
Fibre (g/kg)	241	294
Calcium (g/kg)	18,3	5,2
Phosphorus (g/kg)	2,9	2,9
Dry matter (g/kg)	876	880

Alfalfa provides good feed for animals as it has a high protein content, but once in the rumen, legumes are much more fragile than grasses and therefore their digestibility (+15-20% faster degradation within 24 hours) is overall slower than grasses (*Figure 1*). This is the real advantage of meadow hay, as the breakdown of alfalfa in the rumen is 30-40% worse due to its higher lignin content. The two degradation curves intersect between 24-30 hours. Beyond this point, grass fibre degradation is more favourable (OROSZ, 2015).

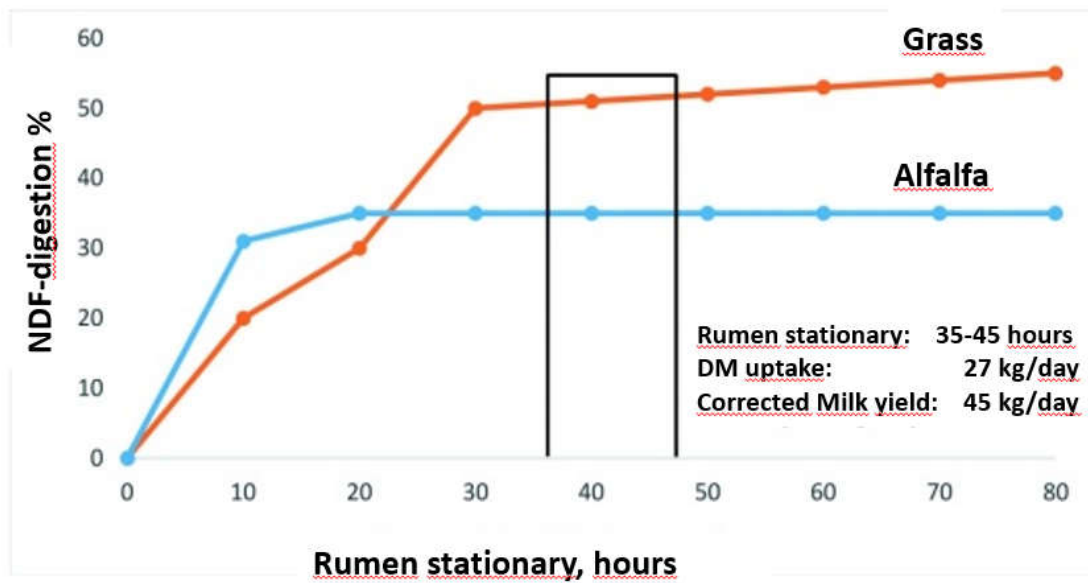


Figure 1: Grass and Alfalfa digestion in rumen (Source: GRANT, 2015)

Grasses fill the rumen more, thus slowing down the outflow (rumen passage rate). The longer rumination time allows more nutrients to be digested and the hard fibres of grasses mean that a smaller amount of meadow hay is sufficient to achieve the same activity. Leaf retention is not an issue in meadow hay production and can be harvested during the day (OROSZ, 2017).

HAY AGROTECH

Producing the right quality feed starts with mowing. The drying time of the hay is greatly reduced by the use of mechanical conditioner, which makes it easier for the plant to shed water by crushing stalks and split leaves. There are two types of conditioners. The flail type design, used more for grasses, and the rubber roller design is preferred for legumes. The flail conditioner cuts the whole plant lengthwise, while the roller crushes the stem to speed up drying. Mower-conditioners need 15-20 horsepower more traction and significantly more expensive than simpler mowers. For this reason, small scale farmers cannot afford this tool.

After mowing, it is advisable to rake the swath to allow it to dry as soon as possible. This can be done with a rotary rake. Correct adjustment is extremely important, as an incorrectly adjusted machine can contaminate the forage with soil increasing ash content.

The swath merger also requires great care, as the wrong setting can leave a lot of feed on the ground or elevated amount of soil contaminates the forage.

Baling is the last operation, which requires the most attention. If it is done too early, the hay may be too wet, but if it is done too late, it will be too dry and the vitamins, minerals will be lost from the forage. Proper compactness is also important as post-drying taking place for days.

MATERIAL & METHODS

We gathered bale core-temperature and humidity data and compared with ambient temperature and humidity in enclosed hay barn. The measurements were carried out in Piliny village (Nograd-county, North Hungary), on a livestock farm. The hay-barn formerly used as a sheepfold for winter feed storage, which was closed and insulated on all sides.

Hay bales transported straight to the barn almost immediately after baling. The building was used as a sheepfold, but has lost this function due to a lack of sheep. There are 4 ventilation doors on one side and an entrance at both ends. The floor is covered with sand and straw before loading. Moisture is moving upwards from the ground therefore straw bedding is a perfect insulator. Ventilation is also important, creating adequate draft with crosswise opened vents and doors. The size of the facility is 60 m x 12 m x 5,5 m, with approx. 4000 m³ airspace. The storage barn capacity is 870 round bales (150Ø x 120W cm). On one side of the storage section there is a safety path to control the entire length of the hay stack.

In practice, core temperature is checked with a reinforcing bar right before transport. The rebar is inserted into the middle of the bale, where fermentation heating is most likely to start. The daily rebar temp check is a perfect monitoring method. In case of serious heat up there is still chance to remove couple of bales. The evaporating moisture changes ambient temperature and humidity which is measured 3 different height. Data was monitored for 21 days in 45 cm depth. Humidity was measured with a temperature and humidity meter. 4 bales were measured daily ($\pm 5\%$ SD) at 4:00 pm.

RESULTS

Initially bale core temperature is rising, peaking at 41°C on Day 5. Then a stagnant stage follows for another 8 days. During this period bale evaporated any remaining moisture, and then settled to a constant temperature of 30°C. After 21 days the drying process halts. Overall, the humidity followed the variation of the bale temperature. The highest values were on Day 5 and 9 (*Figure 2*).

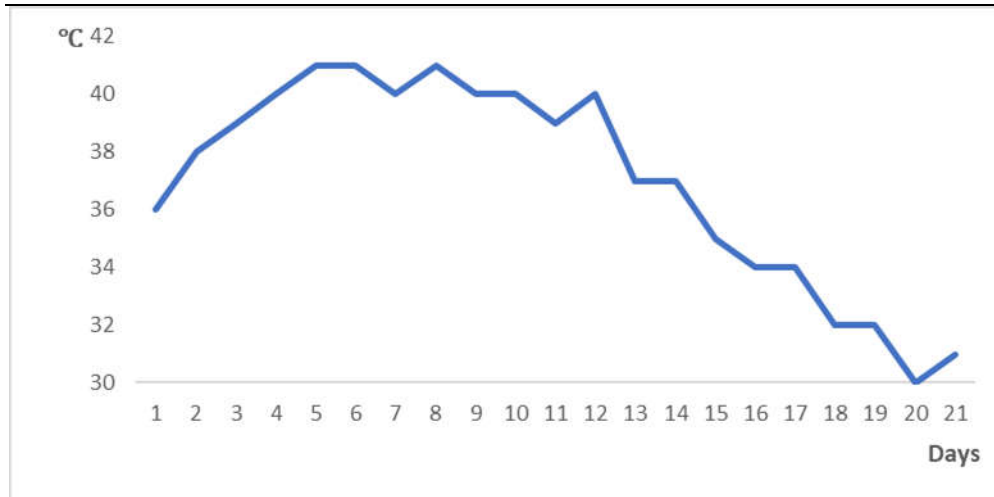


Figure 2: Bale core temperature on the first 21 days.
(4 marked bales/day)

DISCUSSION

Hay quality largely depends from species composition, water- and nitrogen supply. Dicots and C₄ grasses significantly increase fibre content (HALASZ ET AL., 2021). Higher crude protein content is associated with faster drying time (OROSZ & MEZES, 2007). Therefore, high protein in leaves, inevitably sticks with moist stems, which is a straightforward formula to apply mower conditioner. The quicker dries your leafy hay, more valuable protein You save (COBLENTZ ET AL., 2004). Despite proper hay management (TOTH, 2011), quality issues are still not a priority. Climate change and growing fertilizer prices drag in the quantitative issues. In daily practice the “*How many bales You got?*” is still more important than “*How much did it cost?*” and “*How much supplements You saved?*”.

CONCLUSIONS

Hay making does not end with storage. Bales continue to breathe and release water for weeks. Improper work and timing will degrade the hay quality and could lead to stack-fire. During our field test there was no extreme heating (danger zone 55 °C), bales did not heat up more than 41°C. Lower core temperature means less nutrient loss and caramelization.

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NET 1: https://www.ksh.hu/docs/hun/xstadat/xstadat_eves/i_omn007b.html

PEG- INDUCED DROUGHT STRESS EFFECTS ON SPINACH GERMINATION PARAMETERS

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ABSTRACT

Exposure to the drought stress reduces germination rate and seedling's growth with significant variations from crop to crop. An unavoidable consequence of drought exposure is the generation of reactive oxygen species. They can be extremely reactive with several cellular constituents such as proteins, lipids, and nucleic acids. Spinach (*Spinacia oleracea L.*) is one of the most consumed vegetable species, rich in vitamins, such as vitamin C, and minerals, which are essential for human health. Besides, spinach contains large amounts of bioactive molecules such as glucuronic acid derivatives of flavonoids and p-coumaric acid derivatives that exhibit strong antioxidant activity. Osmotic solutions of polyethylene glycol (PEG) are commonly used to control water potential in seed germination studies. PEG reduces the water potential of osmotic solutions but may limit oxygen availability to germinating seeds. The purpose of this study was to determine whether seed immersion in PEG solution had a detrimental effect on total Germination percentage, Relativized percentage, Mean germination time, Mean germination rate, Coefficient of variation of germination time, Coefficient of the velocity of germination, Germination index, Uncertainty of germination process, Synchronization index, Time to 10% germination, Time to 25% germination, Time to 50% germination, Time to 75% germination, Time to 90% germination, Time from 10 to 90% germination, Time from 25 to 75% germination, Mean daily germination Percent, Peak value for germination, Germination value. A controlled experiment was conducted to investigate the effects of drought stress, induced by PEG, on these germination parameters in Spinach. For control, seeds were treated with nutrient solution, and 2.5% PEG was used to induce drought stress. The seeds were germinated geotropically between moisten filter papers. Each roll contained 30 seeds. Overall germination parameters showed a decrease as compared to control. The germination percentage of control seeds of *Spinach oleracea L.* was 79% while those treated with PEG were only 63%. Similarly, the relativized percentage decrease was observed in the case of PEG-treated seeds. Relativized percentage of control seeds was 91% as treated seeds were only 73%. Both showed a significant decrease as compared to the control.

Keywords: : Drought stress, Germination, Spinach, PEG

INTRODUCTION

Spinach (*Spinacia oleracea L.*), associated to family Chenopodiaceae, is one of the most famous green leafy vegetable crops with minimum growth cycle and is an annual plant (Biemond et al., 1996). Spinach is highly nutritious due to presence of minerals and vitamins. It is a good source of calcium, vitamin C, phosphorous, iron, potassium and sodium (Dicoteau, 2000, Morelock, T.E. and Correll, J.C., 2008). It originated from central Asia, probably from Persia. 31,770 ha are dedicated to its cultivation in the countries that are from the European Union. Spinach covers about 5100 ha and annual production is about 86,990 tons in Spain. It was introduced to Spain by Arabs and subsequently finding its way into the rest of Europe according to Kaur et al., (2011) in the book Origin of Cultivated Plants (Murcia et al.). Changing climate and lack of proper irrigation is

enhancing drought conditions which creates hindrance in the cultivation of crops (Anjum et al., 2011). The crucial phase in the life cycle of plants is seed germination, which determines the successful establishment of seedlings and subsequent growth. In the initial stage, plants are more sensitive to environmental stresses than other growth and developmental stages (M'barek et.al (2007), Luan, Z.et.al. (2014). Abiotic stresses like drought, heat, heavy metal and light have a significant effect on seed germination and related parameters (Bhattacharya, et al., 2012). In extreme cases these factors may lead to injury and death of the plant. One of the major constraints impairing crop growth around the globe is drought stress. The first stage of germination is the absorption of water. Seeds, whether dead or alive, absorb water and swell and the quantity of absorbance depends on the chemical composition of seeds. Germination declines or stops if the water level is less than desirable as the main factor of stimulating germination is water and access to water by osmotic and matric potential (suction) is reduced (Baskin, C. C., et al., 1998). Rate of water absorption depends on the water potential of environment. Drought can reduce the germination rate but sensitivity towards drought stress differs at different stages of germination (Ahmad, S.et.al. 2009). With increasing severity of the drought, the percentage and rate of germination, germination index was reduced in several species (Alqudah, et al., 2011). Drought stress affects many aspects of plant growth delay in germination, reduction in the growth of shoot and reduce the production of dry matter (Shekari, 2000). Drought stress not only decreases overall plant growth, but also leads the cultivatable land into barren non-cultivable area. This reduction in the crop yield is mainly attributed to a disturbance in the biochemical and physiological processes under drought condition (Hoekstra et al., 2001). It is believed that due to accumulation of higher amount of ethylene in plants facing drought stress, the yield is reduced. Ethylene plays an important role in evoking the physiological responses under drought stress (Wang et al., 2003). So, the current study was conducted with the aim to explore the effect of PEG-induced drought stress on the various germination parameters of Spinach seeds. It is hypothesized that the PEG will lead to decrease in the germination rate and germination index as compared to control, but differences are expected in terms of sensitivity of parameters to drought.

MATERIAL AND METHODS

Spinach Seeds (*Spinacia oleracea* var. *Matador*), taken from Garafarm trade Kft. Budapest were surface sterilized using 6% [v/v] H₂O₂ for 20 minutes, after that washed and rinsed extensively with deionized water. The treatment of 2.5% concentration PEG 6000 [VWR international bvba Geldenaaksebaan, Leuven, Belgium] solution was applied to the seeds in three replicates, and for control treatment, the nutrient solution was applied. The nutrient solution consisted of the following substances: 2.0 mM Ca (NO₃)₂, 0.7 mM K₂SO₄, 0.5 mM MgSO₄, 0.1 mM KH₂PO₄, 0.1 mM KCl, 10 μM H₃BO₃, 0.5 μM MnSO₄, 0.5 μM ZnSO₄ and 0.2 μM CuSO₄. Iron was supplied in the form of 10⁻⁴M Fe-EDTA too (Cakmak and Marschner 1990). The seeds were germinated geotropically between moisten filter papers at 24 °C. Each roll contained 30 seeds. Seed germination was counted every day, and the daily associated root elongation was measured with ruler. From the germination counts, the following germination parameters were determined after 7 days of sowing:

Germination percentage: $G(\%) = \frac{\sum_{i=1}^k n_i}{N} \times 100$

Relativized percentage: $R(\%) = \frac{AP}{HP} \times 100$ (Fitch et al. 2007)

Mean germination time: $\bar{t} = \frac{\sum_{i=1}^k n_i t_i}{\sum_{i=1}^k n_i}$ (Ellis and Roberts 1981)

Mean germination rate: $\bar{v} = \frac{1}{\bar{t}}$ (Ranal et al. 2009)

Uncertainty of germination process: $U = \sum_{i=1}^k f_i \log_2 f_i$ (Labouriau and Valadares 1976)

Where; $f_i = \frac{n_i}{\sum_{i=1}^k n_i}$ f_i = Relative frequency of germination

Synchrony of germination process: $Z = \frac{\sum_{i=1}^k C_{n_i, s}}{C_{\sum n_i, s}}$ (Labouriau 1978)

Coefficient of variation of germination time: $CV_t = \frac{s}{\bar{t}} \times 100$ (Ranal et al. 2009)

Germination index: $GI = \sum_{i=1}^k n_i / t_i$ (AOSA and SCST 1993)

Coefficient of velocity of germination: $CVG = \frac{\sum_{i=1}^k n_i t_i}{\sum_{i=1}^k n_i} \times 100$ (Jones and Sanders 1987)

Time to 50% germination: $T_{50} = \frac{t_i + \left(\frac{\sum_{i=1}^k n_i}{2} - n_i \right) (t_j - t_i)}{n_j - n_i}$ (Coolbear, Francis, and Grierson 1984)

In the above equation to find out the value of n_i and n_j there is need to look in the cumulative number of seeds germinated for which the condition is given below.

$$n_i < \frac{\sum_{i=1}^k n_i}{2} < n_j$$

Where; n_i = nearest cumulative number of seeds germinated (C_{n_i}) $< \frac{\sum_{i=1}^k n_i}{2}$

n_j = nearest cumulative number of seeds germinated (C_{n_j}) $> \frac{\sum_{i=1}^k n_i}{2}$

t_i = the time interval corresponding to n_i

t_j = the time interval corresponding to n_j

Other time related germination parameters like T10, T25, T75 and T90 were calculated using the same above formula by replacing $\frac{\sum_{i=1}^k n_i}{2}$ with $\frac{\sum_{i=1}^k n_i}{10}$, $\frac{\sum_{i=1}^k n_i}{4}$, $\frac{3 \sum_{i=1}^k n_i}{4}$ and $\frac{9 \sum_{i=1}^k n_i}{10}$ respectively.

Mean daily germination percent: $\bar{G} = \frac{GP}{T_n}$ (Adams and Farrish 1992)

Germination value: By combining both speed and completeness of germination into a composite score as described by Czabator (1962).

$$GV = MDG \times PV$$

Experimental design and statistical analysis: Treatments were arranged in a completely randomized design with 3 replications and 30 seeds per replicate. For statistical analysis SigmaPlot 12 for Windows (Systat Software) was used. During the data analysis, t test was used.

RESULTS

Severe effect of drought was observed on various germination parameters. Significant decrease of 20% in germination percentage was recorded in PEG treated seeds in comparison to control. Similar to germination percentage, relativized percentage also decreased by 19.75% under drought condition (*Table.1*).

Mean germination time decreased by 27.1% in PEG treated seeds in comparison to control. However, mean germination rate of control was less as compared to PEG treatment, 0.26 day⁻¹ in case of control and 0.35 day⁻¹ in PEG treated seeds. Decrease of 18.14% in coefficient of variation of germination time compared with control was recorded (*Table.1*). Coefficient of velocity of germination was high (28.37%) in PEG treated seeds than control (*Table.1*). Decrease in germination Index by 5.96% was recorded in PEG treated seeds (*Table.1*).

Mean daily germination values also showed the significant decrease by 19.8% in PEG treated seeds. Decrease by 17.9% in germination value was recorded in drought condition. Time to 25% germination, Time to 50% germination, Time to 75% germination, Time to 90% germination, Time from 10 to 90% germination, Time from 25 to 75% germination also decreased in case of PEG treatment along the slight increase in peak value of germination as shown in table 1.

Table 1. Comparison between control and treatment among various parameters [n=3±SE] where n= no. of replications, SE= standard error.

Germination Parameters	Units	Control	2.5% PEG
Germination percentage G%	%	79 ± 4.93	63 ±1.92
Relativized percentage R%	%	91± 5.50	73.07± 2.24
Mean germination time MGT	day ⁻¹	3.91±0.45	2.85±0.29
Mean germination rate MGR	day ⁻¹	0.26±0.03	0.35±0.03
Coefficient of variation of germination time CVt	%	52.07±6.63	42.61±5.41
Coefficient of velocity of germination CVg	%	26.28±3.16	35.69±3.34
Germination index GI	day ⁻¹	9.06±2.23	8.52±1.21
Uncertainty of germination process U	bit	2.37±0.16	1.97±0.12
Synchronization index Z		0.20±0.03	0.26±0.03
Time to 10% germination	day	0.916±0.458	0.466±0.466
Time to 25% germination	day	1.402±0.713	1.216±0.656
Time to 50% germination	day	3.437±0.598	2.269±0.321
Time to 75% germination	day	5.027±0.701	5.027±0.701
Time to 90% germination	day	6.222±0.308	3.922±0.067
Time from 10 to 90% germination	day	3.405±1.712	0.833±0.833
Time from 25 to 75% germination	day	2.236±1.311	0.870±0.435
Mean daily germination MDG	%	11.269±0.691	9.047±0.274
Peak value for germination	day ⁻¹	16.666±5.091	17.500±1.734
Germination value		194.19±69.60	159.26±20.20

DISCUSSION

Overall decrease in germination parameters was observed. Drought leads to decrease in water potential in germination medium and prevents water absorption needed for germination process to start (Almansouri, M., J.M. Kinet, 2001). These results are in agreement with those reported by Dahal et al. (1996), Zayed et al. (1998), Lopez et al. (2000), Almansouri et al. (2001) and by Zhu et al. (2006). PEG not only delayed the germination but also affected the final germination percentages. Our results are not in agreement with those reported by Bradford (1990) and Almansouri et al. (2001) who stated that moderate osmotic stresses only delayed germination while high stresses reduced the final germination percentages. PEG, which is a non-penetrating osmoticum, prevents water uptake by plant cells. Yadvi et al (2000) concluded that germination percentage was decreased as osmotic potential goes to negative under drought stress caused by (PEG6000) on 6 barely cultivars.

In seeds that are soaked in nutrient solution, their water content reaches a plateau and up to just before radicle emergence changes very little. When the water potential is reduced outside the seeds media, the rate of water uptake decreases and the onset of germination is delayed. The major reason for germination delay is the increase in the length of the lag phase between imbibition and radicle growth, since the increase in seeds water content proceeds slowly during this period. In nutrient solution, seeds are saturated (100%) with nutrient solution and as a result radicle growth occurs rapidly, but at higher osmotic potential (more negative) seeds water content increases gradually (Bradford, K.J., 1986). According to Bradford (1990), at high osmotic potential the degree of seeds endosperm weakening which primarily controls the time of radicle emergence due to lowered seed water potential or pressure potential (turgor) is delayed.

In conclusion, in this study drought tolerance in early phase of seedling growth of spinach was investigated by evaluating growth and germination process under PEG-induced water stress. It was observed that water stress causes delay and also inhibition of germination process which could be due to various physicals and metabolic parameters, the absorption of water by the seed [imbibition] activates metabolic processes that subsequently lead to expansion of the embryo and the penetration of radicle through surrounding tissue. Enzymatic hydrolysis of protein, lipids and carbohydrates and transportation of metabolites is dependent on water availability (Nonogaki, H., Bassel, G. W., & Bewley, J. D. 2010), which plays an important role during germination.

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ORGANIZATIONAL STRATEGIC MANAGEMENT RESPONSES AND CONSEQUENCES DURING COVID-19 ERA

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ABSTRACT

One consequence of the COVID-19 pandemic is that companies based on conventional (linear) value creation logic and traditional management solutions, even agricultural enterprises, are forced to make such strategic decisions and apply such strategic planning techniques which have not characterised them so far.

My basic assumption is that the circumstances have been triggered and accelerated the linear–nonlinear transformation at companies. In this sense, during the value creation of linear organisations, special sets of functions emerge that are nonlinear in their nature. These include the development of adaptation skills, activities focusing on innovation, creativity management, rethinking of HRM, coordinating digital transformation, and all the skills which are needed to successfully respond to an increasingly unpredictable (complex) operating environment.

The aim of the paper is to take a snapshot of the current literature dealing with strategic management responses on the consequences of pandemic and – in the same time – categorize the main suggestions, conclusions of the selected papers and documents in line with the steps of the strategic management process. In addition, I want to point out the core essence of the nonlinear management approach reflecting on the content of the literature. Finally, I analyzed the managerial responses of the Hungarian Blue Chip companies in line with the pandemic. The literature suggests a really wide range of solutions to handle the current situation affecting almost all of the most relevant strategy-making areas. The results show that the linear–nonlinear transformation has started in Hungary as well, but in many cases it is still in its infancy.

Keywords: COVID-19, literature review, nonlinear approach, strategic management, complexity

INTRODUCTION

The processes of the surrounding nature show the typical signs of nonlinearity (complexity). These types of systems differ from human-preferred, predictable, controllable linear systems, which are mostly human-made, artificial systems. The nonlinear world – with its own rules and peculiarities – cannot be made linear/predictable to an unlimited extent, even if humanity thinks so (NAGY, 2015).

Moreover, it seems as if these phenomena are appearing more and more often: we sometimes have to face and adjust to events that are very unlikely to occur (MÉRŐ, 2018; TALEB, 2010). Others refer to these nonlinear conditions as a VUCA environment. VUCA is an acronym, first used in 1987 and based on the leadership theories of BENNIS AND NANUS (1985). VUCA means *Volatility, Uncertainty, Complexity* and *Ambiguity* (VUCA-WORLD.ORG).

We live and try to create value under such conditions in which unpredictability, nonlinearity, complexity become more and more relevant.

Such a creature can survive and continue to exist which is able to adapt intelligently to these turbulent conditions. The same is true for companies, especially in a pandemic period like the current one.

This turbulent/nonlinear environment affects – obviously – the organizations' strategic and leadership aspects as well, so traditional experiences, paradigms and the linear thinking should be reappraised.

This short description tries to capture the essence of such systems, but it does not give the whole picture. Those systems are considered complex and adaptive (or VUCA environment) which can be described with the following properties (BOISOT AND MCKELVEY, 2011; DINYA, 2008; KAISLER AND MADEY, 2009):

- large number of heterogeneous agents or elements arranged in structures,
- these agents interact locally and are connected with each other directly or even indirectly,
- there are basic/simple rules inducing, enforcing self-organization and system (nonlinear) dynamics (the system changes over time),
- non-linearity: slight changes in the initial conditions of the system status induce: (1) large, (2) small changes or (3) do not cause any change at macro level,
- feedback mechanisms in the system facilitate the adaptation,
- emergent features and patterns on macro level owing to the system dynamics,
- far-from-equilibrium state,
- interdependencies and optimal adaptation at the edge of chaos in response to environmental changes.

Translating the above mentioned characteristics to VUCA environment, the following statements can be made (BENNIS AND NANUS, 1985; GEORGE, 2017; VUCA-WORLD.ORG):

- Constantly evolving conditions and rapidly changing environment,
- The changes become more and more unpredictable,
- Events unfold in completely unexpected ways,
- It's becoming more difficult to anticipate events or predict how they will emerge,
- Forecasts and extrapolations based on retrospective analyses and past experiences are losing their relevance and are rarely applicable as a starting point for future predictions,
- These circumstances of course change the former risk assessment and risk management tools,
- Problems and their consequences are more compound and become harder to understand.

In order to manage the nonlinearity, complexity and the VUCA environment sufficiently, the only way for a proper response is if we increase our organization's nonlinearity and agility as well. Mixing the nonlinearity and organizational theory is not a newfangled idea. Such nonlinear companies can be better in responsiveness, organizational resilience, financial sustainability, they are more efficient and prosperous than a traditional/linear/bureaucratic one (NAGY, 2015 quotes: ALLEN, 1988; BURNS AND STALKER, 1961; BROWN AND EISENHARDT, 1997; MORGAN, 1997 in LEVY, 2000).

The changes in the external environment should be treated not as threats rather new possibilities for higher value creation. It is obvious that the leadership style should be also adjusted for exploitation of the benefits stemming from the complexity (BENNET AND BENNET, 2008; HAZY, 2008; SURIE AND HAZY, 2006).

The inherently nonlinear companies have the following characteristics:

- these companies mainly operating in knowledge-based, information economy especially in technology sector – producing nontraditional products and services;
- they non-traditional inputs intangible resources: e.g. special knowledge, creativity, information, network positions, special skills;

- the operation of the value creation processes can not be pre-designed, predicted, pre-simulated;
- innovative ideas, information, knowledge are generated or transferred by nonlinear systems;
- new, more efficient management and HR management functions are developed under the new paradigm;
- *New generation* companies using non-traditional resources usually have greater potential for growing and realize more added value.

There are several concepts and ideas however which try to handle the nonlinearity on an organizational level. Some remarkable example can be mentioned:

- VUCA leadership concept (GEORGE, 2017)
- Complexity Leadership Theory (UHL BIEN ET AL., 2007)
- Organizational agility (MCKINSEY & COMPANY, 2015)
- Cynefin framework (KURTZ AND SNOWDEN, 2003)
- Creativity management described in the Books *Collective Genius* (HILL ET AL., 2014) and *Creativity, Inc.* (CATMULL AND WALLACE, 2014)

DINYA (2008) also drew attention to the underlying (and necessary) paradigm shift. According to him, the difference can be seen in three areas (*see the following Tables: 1., 2. and 3.*).

Table 1: A brief comparison between traditional and nonlinear companies according to the cultural paradigm shift

Cultural Paradigm	
Traditional companies	Nonlinear companies
minimize risk!	we learn from failures
who is not with us – is against us!	who is not against us is with us!
great profit, faster growth	great profit, more innovation
you're worth as much as you sell	you're worth as much as you know (<i>e.g.</i> creativity or special skills)
the key to success is a professional management	the key to success: an excellent community

Source: based on DINYA (2008)

Table 2: A brief comparison between traditional and nonlinear companies according to the management paradigm shift

Management Paradigm	
Traditional companies	Nonlinear companies
the world of business: constant competition	the world of business: constant adaptation (to build up resilience and the ability to react intelligently)
the organization: an oiled machine	the company: self-organizing organism
the main managerial task is the control over the resources and human resources as well	the main managerial task is the service, to create an enabling working environment
leadership: managing the workforce	leadership: employee support
environmental change is a threat	environmental change is a great opportunity to create value

Source: based on DINYA (2008)

Table 3: A brief comparison between traditional and nonlinear companies according to the organizational paradigm shift

Organizational Paradigm	
Traditional companies	Nonlinear companies
regulated (linear) input-output relationships	nonlinear behavior
stable, balanced operation	high flexibility
centrally controlled	self-organizing system
emphasis on integrated internal processes	emphasis on intense environmental relationships
harmony among strategy – tactics – operational goals	balance between chaos and order

Source: based on DINYA (2008)

In this context, I was curious about the strategic management implications of the new situation induced by COVID-19.

MATERIALS AND METHODS

This article is basically a systematic literature review with additional primary research affecting practical aspects.

A review of the literature can be conducted on the basis of various aspects. This synthesis was made taking into account the phases of the strategic management process and puts the linear-nonlinear transformation in focus. My basic hypothesis is that the current pandemic period – with its unpredictability and nonlinear nature – accelerates and prioritizes nonlinear transformation in relation to traditional companies as well, which means in my interpretation that more and more solutions are used in the short term or during strategy-making.

I have defined three research areas in this article:

- (1) Literature coverage of the strategy management processes induced by the COVID-19. (snapshot of current professional and academic opinions on the strategic responses in the light of pandemic and nonlinear management).
- (2) Synthesis of the literature in the light of nonlinear management aspects of the pandemic.
- (3) The focus of the management responses of the Hungarian Blue Chip companies for the financial year 2020.

To examine these areas, I collected relevant articles and documents, supplemented with the Annual Reports of the most significant companies of the Budapest Stock Exchange. The shares of the selected 16 companies are components of the BUX basket.

I selected and analyzed a total of 30 articles and documents to get a better insight to the current opinion of the academic researchers and professionals. Literature embraces the most recent and relevant publications written and edited by scientists, experts and

professional consulting firms. Sources of these papers were the databases of Google, Google Scholar, Scopus, Web of Science and articles covered by GARCÍA-MADURGA ET AL. (2021).

Inclusion criteria were:

- research articles published (or in press) in scientific journals,
- documents published by global organizations and consulting companies,
- published during 2020-2021,
- written in English,
- focus areas: business management or social sciences,
- keywords or topics including at least one of the following expressions: COVID-19, business, strategy, management and leadership, digital transformation, change.

Exclusion criteria were:

- public sector organizations,
- conference transcriptions,
- books or book chapters.

In order to analyze the above mentioned three research areas, I chose organizational strategic management as an analytical framework because in this regard we can catch the long-term commitments of the given company and, at the same time, the implementation of the strategy requires short-term thinking as well.

MAROSÁN (2006) uses a sufficiently detailed framework. It has 3 main categories and 14 subcategories. I. Strategic analysis: 1. intentions and interests (vision, mission, values); 2. analysis of the external environment; 3. analysis of the internal situation. II. Decision on strategic actions: 4. elaboration of different versions (general goal settings, scenario planning); 5. comparison of alternatives/versions; 6. strategic decision (strategic objectives). III. Strategy implementation: 7. resource planning (including financial and efficiency aspects, capacity building, value chain planning); 8. shaping organizational structure (formal & informal); 9. building organizational culture; 10. implementation; 11. management and leadership; 12. control mechanism; 13. change management; 14. feedback and learning. Of course, the individual components are not necessarily separate from each other, as they are often built on each other and are organically connected. The application of this framework is also supported by the fact that it is much more detailed than the commonly used strategic analysis tools (*see e.g.* KORNELIUS ET AL. 2021).

To match and to categorize the literature, suggestions, thoughts and companies' reactions in line with the proper strategic management component, I use content analysis of the selected documents. To describe the nonlinear management transformation, I used DINYA'S (2008) categorization: cultural, management and organizational paradigms.

RESULTS

Results are presented in the order of the research areas.

(1) Literature coverage of the strategy management processes induced by the COVID-19

The following Table (*Table 4.*) contains all the steps of the strategic management process and the related publications. It could help us to answer the first research question. This points out the wide spectrum of the authors' interests and research focus.

Table 4: Steps of the strategic management process and the distribution of the analysed literatures according to their main focus

Steps of the strategic management process	Related publications
I. Strategic analysis	In general: X
1. intentions and interests (vision, mission, values)	AXSON (2020), HUY (2020), PwC (2020b)
2. analysis of the external environment	DI VAIO ET AL. (2020), HUY (2020), PwC (2020b), SCHALTEGGER (2020)
3. analysis of the internal situation	HUY (2020), PwC (2020b)
II. Decision on strategic actions	In general: X
4. elaboration of different versions (general goal settings, scenario planning)	AXSON (2020), DI VAIO ET AL. (2020), HUY (2020)
5. comparison of alternatives/versions	X
6. strategic decision (strategic objectives)	McKINSEY & COMPANY (2020)
III. Strategy implementation	In general: AXSON (2020), BATRA (2020), PUTRA ET AL. (2020), PwC (2020a)
7. resource planning (including financial and efficiency aspects, capacity building, value chain planning, business models, HR aspects)	ALMEIDA ET AL. (2020), AXSON (2020), BATRA (2020), BOND III ET AL. (2020), BREIER ET AL. (2021), CASALINO ET AL. (2020), CRICK AND CRICK (2020), D'ALIZZA AND DARRELL (2021), DELOITTE (2020), DI VAIO ET AL. (2020), HAMILTON (2020), IBM (2020), IFC (2021), KRAMMER (2021), McKINSEY & COMPANY (2020), PATUELLI ET AL. (2021), RENJEN (2020), RITTER AND PEDERSEN (2020), RAPACCINI ET AL. (2020), SCHALTEGGER (2020), SEETHARAMAN (2020)
8. shaping organizational structure (formal & informal)(including information flow structures, stakeholders, cooperation)	CRICK AND CRICK (2020), DELOITTE (2020), DI VAIO ET AL. (2020), GARCÍA-MADURGA ET AL. (2021), IBM (2020), IFC (2021), McKINSEY & COMPANY (2020), PUTRA ET AL. (2020), PwC (2020b), RAPACCINI ET AL. (2020), SEETHARAMAN (2020), SHETH (2020)
9. building organizational culture	CASALINO ET AL. (2020), D'ALIZZA AND DARRELL (2021), DELOITTE (2020)
10. implementation (including sustainability aspects)	DI VAIO ET AL. (2020), HUY (2020), PATUELLI ET AL. (2021), SCHALTEGGER (2020)
11. management and leadership (including risk management, innovation and knowledge management)	ALMEIDA ET AL. (2020), CASALINO ET AL. (2020), GARCÍA-MADURGA ET AL. (2021), HAMILTON (2020), KRAMMER (2021), LUNGU ET AL. (2021), McKINSEY & COMPANY (2020), PUTRA ET AL. (2020),

	PWC (2020b)
12. control mechanism	X
13. change management (including adaptability, resilience, agile change management, digital transformation)	ALMEIDA ET AL. (2020), CASALINO ET AL. (2020), COOMBS (2020), D'ALIZZA AND DARRELL (2021), DELOITTE (2020), HAMILTON (2020), IBM (2020), IFC (2021), KAMAL (2020), KRAMMER (2021), LUNGU ET AL. (2021), PATUELLI ET AL. (2021), PUTRA ET AL. (2020), RAPACCINI ET AL. (2020), SEETHARAMAN (2020)
14. feedback and learning	BATRA (2020), CASALINO ET AL. (2020), DELOITTE (2020), HUY (2020), SCHALTEGGER (2020)

Source: based on MAROSÁN (2006)

Looking at the table above, it appears that the selected references cover almost all the steps with their comments and suggestions.

As we can see the *5th step: comparison of alternatives/versions* and the *12th step: control mechanism* are missing in this listing. The possible answers for this could be as follows:

5th: in this rapidly changing environment (COVID-19) the comparison of different alternatives could seem to be unnecessary and resource wasting activity, because most of the companies are already satisfied if they can elaborate one proper strategic direction.

12th: the importance of control mechanisms is greatly underestimated in the literature and does not receive the attention it deserves. This situation can also be observed here. However, well-functioning control processes/systems serve the sustainability of systems (including enterprise systems as well) in either a financial or extended sense. In my opinion, the science of management should deal with control systems tailored to nonlinear structures in the near future. Like any other corporate activity, the operation of control can be a factor in competitiveness. Please, keep in mind that the traditional managerial control significantly differs in its nature and logic from the nonlinear control mechanism.

(2) Synthesis of the literature in the light of nonlinear management aspects of the pandemic

The following subsection presents the recommendations and core essences based on literature review regarding COVID-19 and post-COVID business era. The classification is based on paradigms described in the previous chapter (DINYA, 2008). All the suggestions can be used at traditional companies as well (Source: ALL LITERATURES listed in *Table 4.*).

Cultural Paradigm:

- innovation, innovative thinking, customer and stakeholder orientation,
- HR engagement, motivation, internal employees' wellbeing, health orientation, trust,
- companies that can spot problems when they look small, learn from them and build preventive measures rapidly possess what we would call a strong organisational immune system,

-
- clear vision, values, soft elements, optimism,
 - social responsibility, join larger level visions, missions,
 - recognizing the importance of social capital,
 - commitment to environmental sustainability,
 - risk and opportunity intelligence.

Management Paradigm:

- fostering digital transformation,
- HR capacity building focusing on digital skills, promote and enhance digital learning, new digital ways of working,
- launch and sustain a crisis command center,
- increasing efficiency of resources, sustainability (financial as well),
- increasing the quality of data management, privacy and cybersecurity capabilities,
- innovation: empowering and enabling environment within organization, support talents,
- new business models,
- disruptive technologies,
- intelligent data management,
- developing team competencies, internal structures/informal networks,
- financial sustainability (mentioned as a traditional management issue!)(create financial realism: increases flexibility rather than reduces it; simplifies planning by sharpening focus; it remains relevant in bad times as well as good.)(AXSON, 2020),
- redesigned risk assessment and management (how to manage uncertainty), rethinking of low-probability events, early warning system for environmental threats (BATRA, 2020 quotes TEECE ET AL., 2016),
- deep qualitative analysis and scenario planning should be complemented by simulations, AI, machine learning tools, mapping algorithms that could quantify different risks, big data, etc. (HUY, 2020),
- rapid response strategy, agile and holistic change management, adaptability is a mandatory business competency,
- resilient leadership, „coopetition” can be an effective business-to-business marketing strategy in a pandemic
- to create and sustain strategic resilience: encourage inspiration, innovation, and imagination.

Organizational Paradigm:

- developing organizational agility,
- reaching operational resilience,
- increasing user experience for our customers,
- holistic view, network thinking,
- taking into consideration the VUCA-environment (cultural, management and organizational paradigm in the same time),
- companies need long, sensitive feelers and hyper-responsive capability at all levels of the organisation to stay in the pink of health (HUY, 2020),
- building networks, innovation networks integrating government politics,
- the multigenerational relationship with the community, suppliers, and employees often saves the companies.

References to nonlinear approaches and management techniques abound in the literature analyzed, highlighting the impact of COVID-19 for the increasing necessity for such methods.

(3) The focus of the management responses of the Hungarian Blue Chip companies for the financial year 2020

The following table (*Table 5.*) summarizes the orientation of the most important Hungarian publicly listed companies in dealing with the COVID-19 crisis. It can be observed that the concentration pattern around the components (left column) does not match the areas covered in the literature (*Table 4.*).

Table 5: Components of the strategic management process and the distribution of the analyzed companies according to their reactions to COVID-19 (based on Annual Reports for 2020)

Steps of the strategic management process	Related companies
I. Strategic analysis	X
1. intentions and interests (vision, mission, values)	X
2. analysis of the external environment	4iG, ALTEO, Appeninn, AutoWallis, CIG Pannónia, Graphisoft Park, Magyar Telekom, MOL, OPUS Global, OTP Bank, PannErgy, Waberer's International
3. analysis of the internal situation	OPUS Global
II. Decision on strategic actions	X
4. elaboration of different versions (general goal settings, scenario planning)	ANY, MOL
5. comparison of alternatives/versions	X
6. strategic decision (strategic objectives)	Magyar Telekom, Masterplast
III. Strategy implementation	X
7. resource planning (including financial and efficiency aspects, capacity building, value	4iG, AKKO Invest, ALTEO, ANY, AutoWallis, CIG Pannónia, Magyar

chain planning, business models, HR aspects)	Telekom, MOL, OPUS Global, OTP Bank, Richter Gedeon, Waberer's International
8. shaping organizational structure (formal & informal)(including information flow structures, stakeholders, cooperation)	X
9. building organizational culture	OTP Bank
10. implementation (including sustainability aspects)	4iG, MOL
11. management and leadership (including risk management, innovation and knowledge management)	ALTEO, ANY, Appeninn, Graphisoft Park, MOL, PannErgy, Richter Gedeon
12. control mechanism	CIG Pannónia, Magyar Telekom
13. change management (including adaptability, resilience, agile change management, digital transformation)	4iG, ALTEO, ANY, CIG Pannónia, Magyar Telekom, Masterplast, MOL, OPUS Global, OTP Bank
14. feedback and learning	X

Source: based on MAROSÁN (2006)

Reviewing the Annual Reports of these companies, the implications of COVID-19 and their specific content, it can be stated that the linear–nonlinear transformation has begun, but not with the dynamics outlined in the literature (4iG, 2021, AKKO INVEST, 2021, ALTEO, 2021, ANY, 2021, APPENINN, 2021, AUTOWALLIS, 2021, CIG PANNÓNIA, 2021, GRAPHISOFT PARK, 2021, MAGYAR TELEKOM, 2021, MASTERPLAST, 2021a,b, MOL, 2021, OPUS GLOBAL, 2021, OTP BANK, 2021, PANNERGY, 2021, RICHTER GEDEON, 2021, WABERER'S INTERNATIONAL, 2021).

In the case of traditional companies (*e.g.* AKKO Invest, ALTEO, ANY, AutoWallis, Graphisoft Park, PannErgy, Waberer's), such measures appeared mainly which can be considered as classic crisis management responses (occupational health regulations, use of governmental financial support, rescheduling projects). While in the case of nonlinear actors using special inputs or regarding other players under transformation, the approaches and methods mentioned in the literature have also appeared (*e.g.* 4iG, CIG Pannonia, OTP Bank).

Some notable examples of the latter:

CIG Pannónia

In the field of digitization and IT developments, they have successfully introduced their IT system for remote identification. The first phase of education development ideas aiming the development of agile organizational and project operations has been implemented (CIG PANNÓNIA, 2021).

MOL

Through the eSMILE online learning platform, information about COVID-19 and occupational safety was provided to employees working with customers on a daily basis. MOL Group has leveraged its investments in previous years to switch to digital solutions to increase its internal training capacity (MOL, 2021).

OTP Bank

The bank provided large-scale donations to health care facilities, supporting several hospitals with medical equipment, including hospitals in disadvantaged areas of the country (social responsibility)(OTP BANK, 2021).

Of course, the success of crisis management and its real factors can be debated, but it is worth looking at the table below (*Table 6*). The change in the share price reflects the thoughts and opinions of investors regarding the real and expected success of the given company. 14. April 2020 refers to the starting period of the Special Legal Order and the State of Danger in Hungary, while 30. November 2021 is the closing date of this research.

Table 6. Changes in stock prices between the onset of the pandemic and 30. November 2021 (including % change also).

Name of the company	price of the share (HUF)(14. APR. 2020)	price of the share (HUF)(30. NOV. 2021)	change (%) (14. APR. 2020=100%)
4iG	467,5	930	198,93
AKKO Invest	400	423	105,75
ALTEO	730	1700	232,88
ANY	1230	1550	126,02
Appenninn	279,5	254	90,88
AutoWallis	76	121,5	159,87
CIG Pannónia	143,5	394	274,56
Graphisoft Park	4550	3850	84,62
Magyar Telekom	366	413,5	112,98
Masterplast	596	4200	704,70
MOL	2190	2416	110,32
Opus Global	280	233	83,21
OTP Bank	8900	17790	199,89
PannErgy	680	956	140,59
Richter Gedeon	8620	8550	99,19
Waberer's International	780	2390	306,41

Source: Budapest Stock Exchange

The Richter's stagnation and Masterplast's soaring in this regard are quite thought-provoking.

DISCUSSION

In conclusion, we can agree with TEECE ET AL. (2016), who noted: „*Strategic planning should be rather a learning and flexible process that enables organizations to adapt in constantly changing environments.*” Or in other words, strategic planning should be one key factor of an organization's performance to enhance its adaptation to both external and internal changes (BATRA, 2020 quotes TEECE ET AL., 2016). This interpretation is a good expression of what has been said so far.

This phase of work was about only the literature review of course further examinations and research are needed to see the real nature of the transformation processes traditional approach → nonlinear paradigm. This circumstance is also the limitation of this article.

The COVID-19 obviously accelerated and catalyzed this transformation and even in the case of traditional companies the new techniques/approaches listed earlier could be vital or essential to sustain their existence. This can also be observed in Hungarian Blue Chip companies, but this process is far from as fast as the literature suggests.

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**BUSINESS SUCCESS IN PERCEPTION OF
POLISH AND ROMANIAN FARMERS**

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ABSTRACT

A business represents the organized effort of a group of individuals who seek to obtain and market goods and services that meet the demands of society in order to make a profit. Agricultural business are unique in that they requires the application of a specific set of principles and concepts.

Business success has different dimensions, some business owners associate success with financial rewards, while others can define success as satisfaction and completion. In the present article authors want to reveal the perception of Polish and Romanian farmers regarding business success. The perception of farmers regarding business success is emphasized by a study based on a quantitative method. Data were collected through a survey, using as research instrument a questionnaire. The research methodology involved: questionnaire design, questionnaire testing, application the questionnaire, analysis and interpretation of data and drawing conclusions. The survey was made using the application provided by Google (Google Forms), questionnaires were filled online. The questionnaire, was applied among farmers from 2 countries, all respondents manage small and medium sized farms. More precise, authors want to reveal what means success for farmers, which are the factors that determines success in their opinion, what do they do to obtain success in their business.

Keywords: business, success, farmers, perception

INTRODUCTION

The purpose of each business is obtaining profit, but for many owners beside profitability is obtaining success. The success of a business involves its organization in terms of human resources, decision making and work procedures. (PRIBEANU AND TOADER, 2006)

High-performance agricultural exploitations means practice of a performance management in order to promote organizing of farms in the way of efficient use of resources and assuring the incomes. (TOADER, 2005; RUȘEȚ ET AL., 2012)

Agricultural exploitations are ofen subject of changes for achieving performance. Each day farm managers need to manage all resources in the best way and face to all challanges of market. The succes of their business is related to how they manage all the situations they face with. (TOADER ET AL., 2008b; TONEA AND RUȘEȚ, 2007)

Successful managers hold a set of skills, their focus is on achieving the goals of their business. In general, the most important features of successful managers are achieving of an efficient communication, efficient time management, good decision making skills, positive attitude, flexibility, leader, sustainer of continuous improvement, strong

motivating factor for employees. (TOADER ET AL., 2008a; TOADER ET AL., 2008c; TOADER ET AL., 2008d)

According to literature the main factors that determine the success of a business are: realism, flexibility, focus on objectives, fortune (chance, luck), human resources, positive attitude, financial resources, good relation with clients and suppliers, strong motivation, pleasure of managing the business, detailed planning, ability to do what is needed, external collaborators (consultancy).

The purpose of this article is to reveal the perception of Polish and Romanian farmers towards business success and also to see if there are or not differences between their opinions.

MATERIALS AND METHODS

In order to attain the purpose of the article some steps have been made:

- literature review;
- selection of those factors that determines success in business, according to specialized literature;
- questionnaire design;
- questionnaire pre-testing;
- distribution of questionnaire among farmers from Poland and Romania, farmers who manage small and medium size farms;
- analysis and interpretation of data;
- drawing conclusions.

The survey was made using an online questionnaire as research instrument, questionnaire was applied only to those farmers who manage small and medium size farms.

The design of the questionnaire was made with the application provided by Google Forms and in order to respond to questions respondents had to access a link.

Respondents had to answer to 11 questions distributed in 2 sections (general information, success in agricultural business).

Questions from first section "General information" are related to country, gender, age, last educational level graduated, field of study, type of farming activity and if farmers has knowledge about management, marketing, financing in agricultural field.

On second section "Success in agricultural business" farmers had to answer to 4 questions, 2 open questions (1,3), 1 closed question with multiple choice (2) and 1 closed questions with a single correct answer (4). In this way, Polish and Romanian farmers answered to following questions:

1. What mean success for you? (only one word)
2. Which are the factors that determines success in your opinion?
3. What do you do for your business to be a successful one?
4. Do you consider that your business is a successful business?

Questionnaire link was distributed to farmers who manage small and medium size farms and it was open for farmers responses between 1st March 2021 – 10th March 2021. The limitation of this study is that number of participants at the survey is small.

The cohort is represented by 100 farmers (50 from Poland and 50 from Romania) who manage small and medium size farms.

RESULTS

Following the application of the questionnaire, 100 responses were obtained from farmers managing small and medium-sized farms in Poland and Romania. Cohort description can be seen in graphic representations from figure 1.

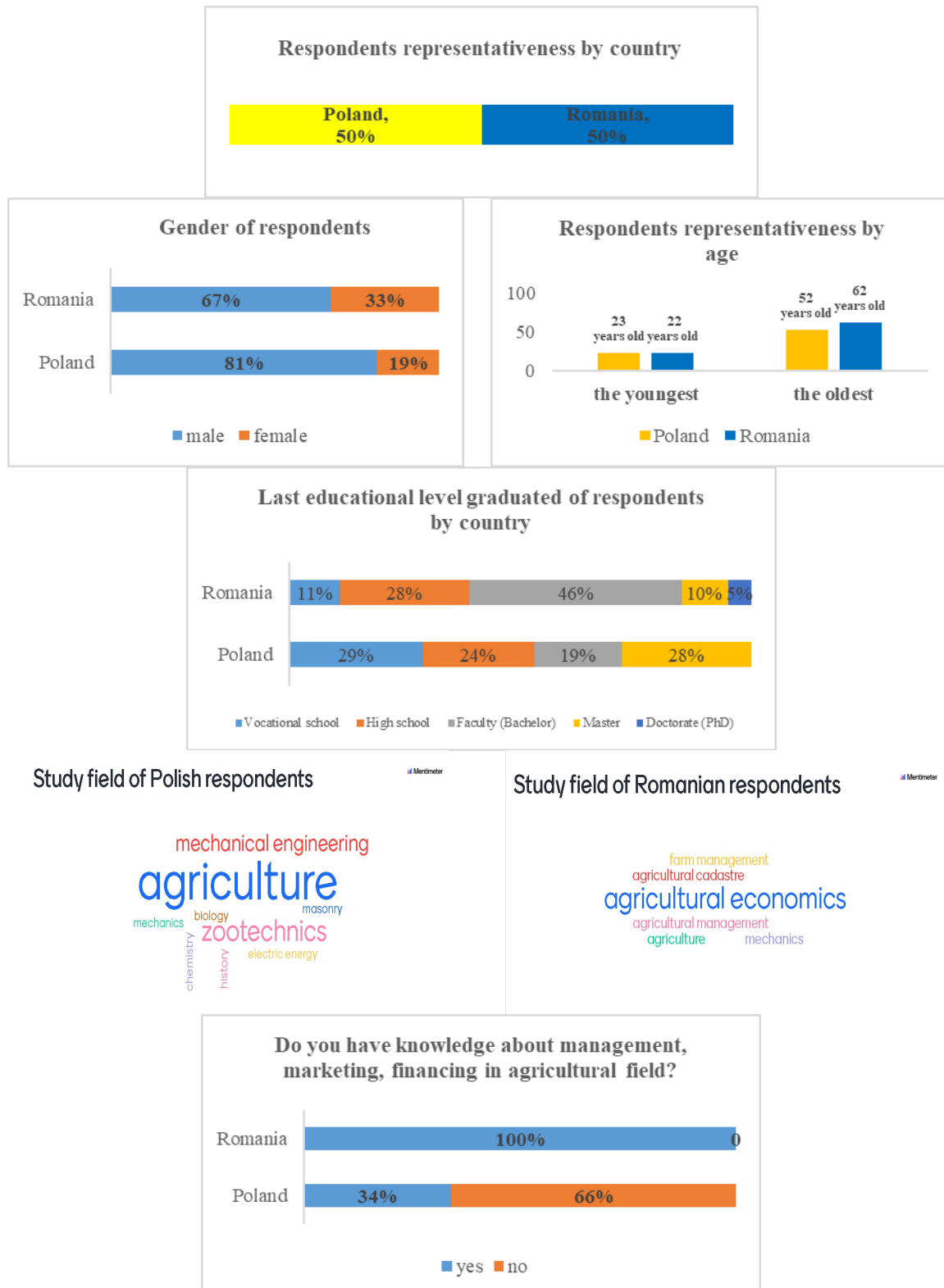


Figure 1. Cohort description

Source: some responses were processed with application provided by mentimeter.com

According to farmers responses, polish farmers associate success with income, satisfaction, profit and even investment, work, family, land, trade, money and for romanian farmers succes means productivity, profit, money and even profitability, growing, dedication. (Figure 2)

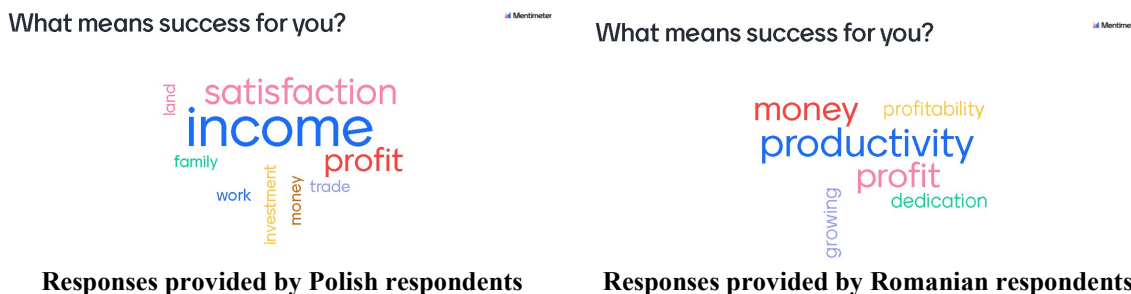


Figure 2. Meaning of success

Source:, responses were processed with application provided by mentimeter.com

Regarding the factors that determines success of a business, in polish farmers opinion the most important factors are human resources, strong motivation, positive attitude and focus on objectives. According to romanian farmers opinion, the most important factors that determines business success are financial resources and realism. Thus, a significant difference can be observed in terms of the perception of Polish and Romanian farmers towards the factors that determine the success of business. (Figure 3)

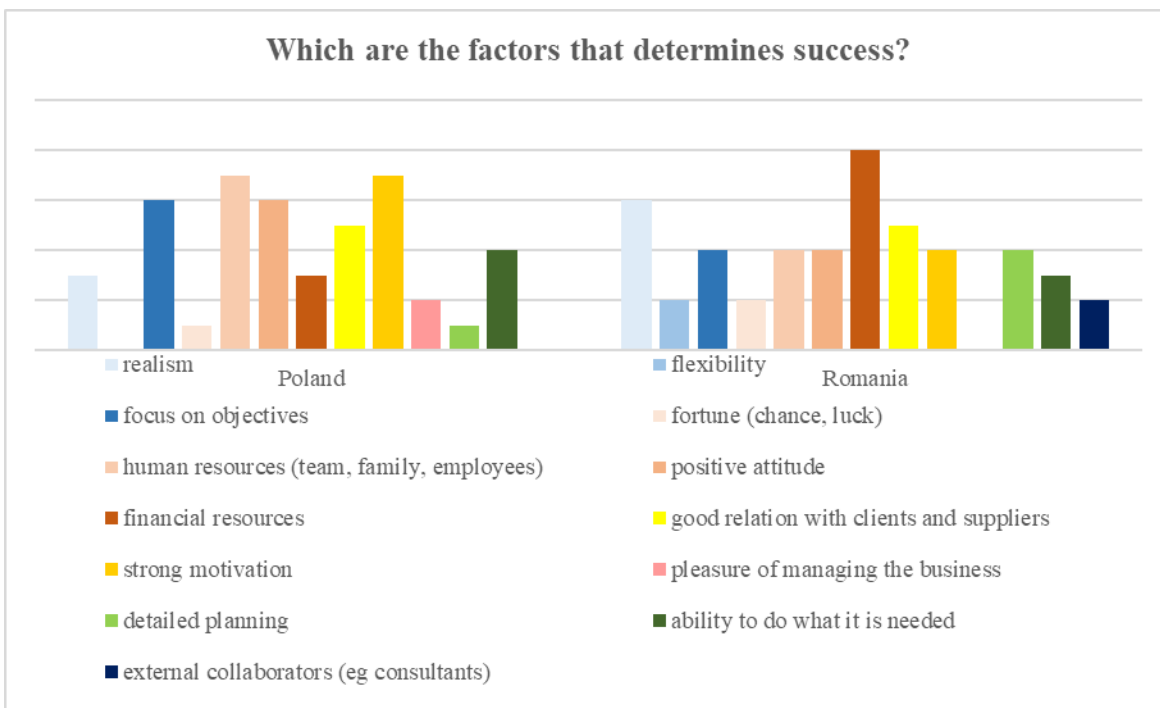


Figure 3. Factors that determines success

Related to the perception about success of own business, most of Polish respondents state that their business are a successful one (81%) and all of Romanian respondents appreciate that their businesses are successful. (Figure 4)

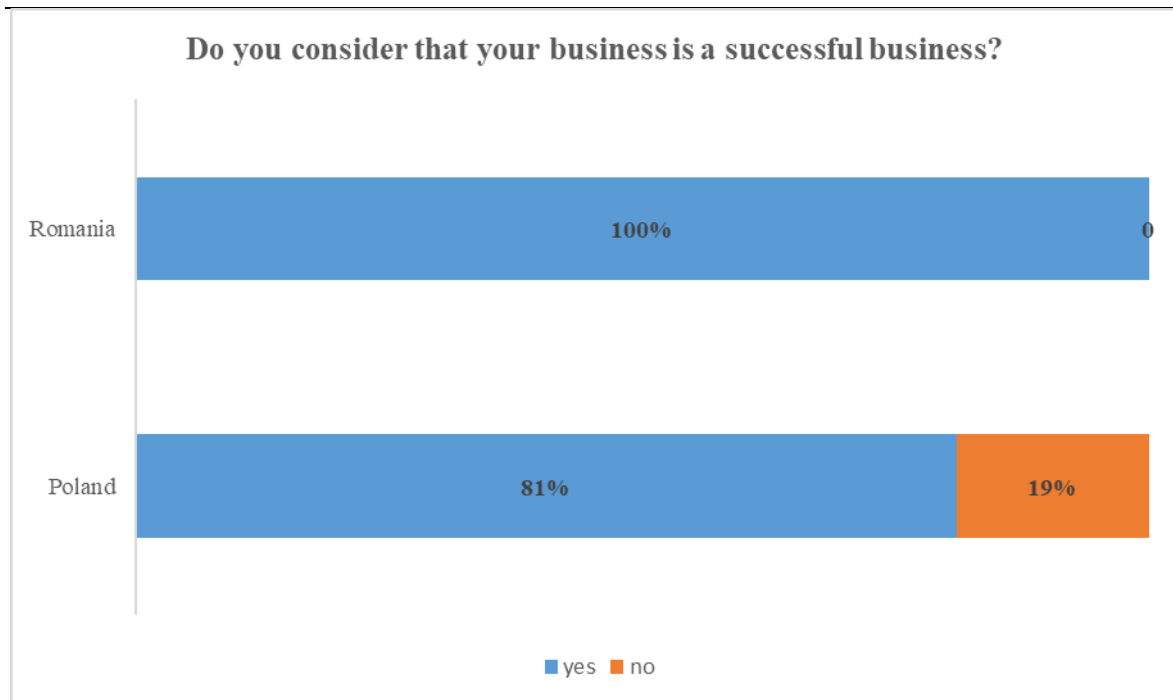


Figure 4. Perception about success of own business

A significant similarity can be observed in terms of the perception of Polish and Romanian farmers towards success of their own businesses. This perception reveals a positive attitude and a pleasure to manage their businesses.

DISCUSSION

Analyzing the answers provided by farmers from Poland and Romania, farmers who manage small and medium size farms, we have noticed the following:

- most of respondents of both countries studied in the field of agronomy, mechanics, agricultural economics and this reveals that business owners are trained in the field of activity of their businesses;
- a large share of respondents have knowledge about management, marketing, financing in the agricultural field and this is an advantage in their activity, because they have the ability to combine all resources to achieve their goals;
- most of them consider that their business is a successful business;
- in farmers' opinion the most important factors that determine success in business are financial resources, realism, strong motivation, positive attitude, human resources, focus on objectives.

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ACCOMODATION TO A "NEW NORMALITY" – RISK OR BENEFIT?

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ABSTRACT

The pandemia generated by the COVID-19 represents first of all a human tragedy, affecting society at its basis, and the effects induced by this boomerang are reflected on the labor market as well. The pandemia has accentuated the need for automation, even on the level of the insurance market, a fact that creates a lot of stress among the employees. The main purpose of the paper is to highlight the situation of the persons employed in various sectors of activity during the current pandemic conditions. The pandemic in the last year prompted large companies to explore more actively the opportunities to automate their activities. In the paper, the authors present the effects of automation on employed people in various fields of activity, including the field of insurance, which has the effect of losing jobs and replacing human staff with the assistance of artificial technology. After the implementation of automation technologies, the roles and way of working of about a quarter of employees have changed globally, while one of ten employees already needed retraining. This trend will continue to grow, with respondents stating that they will have to retrain a third of the workforce in the next three years as a result of the changing roles. The impact upon sales of goods and services is lasting and the insurance companies have to adapt their methods to reach their clients where they are, as well as in way of selling insurance police as in ascertainment of damage and risk inspection.

Keywords: insurances, automation, risk, rate, labor force

INTRODUCTION

After the pandemic, its negative effects could be observed globally on employees, from different sectors of activity. Employment rates have fallen sharply in industry sectors. Where it has been possible, people's work has been replaced by automatic machines.

The short-term priorities were clear from the beginning of the crises. It was obvious, that the first thing to deal with was the emergency health situation, as there is not possible to recover economic issues unless the virus is prevented to spread. (IONESCU, 2020)

At the same time, the protection policies for the people in need, the offer of liquidity to prevent bankruptcy, and to maintain a low rate of unemployment, were the essential elements to ensure a rapid economic restart (NEGRU 2011; NEGRU, 2010).

In this study, we try to present in as much detail as possible the likely impact of automation over time, on jobs in various sectors of activity, but also how its impact evolves.

The insurance sector was also affected both in the country (Romania), as well as globally by the lockdown. Due to severe restrictions, this field has not been so popular and many people have lost their jobs.

All the data presented in the paper are predictions related to automation, how automation affects the staff employed in several fields.

MATERIALS AND METHODS

This study was accomplished by analyzing the available published literature (IONESCU, 2020; NEGRU 2011; NEGRU, 2010; HALALAU, 2011; HUDEA, 2017; TĂNĂSESCU, 2007), case studies (The Digital Economy and Society Index (DESI) 2020; SICOE-MURG, 2017),

and various information from different organizations by studying official reports and websites (<https://www2.deloitte.com>; <https://ec.europa.eu>; PwC estimates based on OECD PIAAC data).

The method we used for this study was the data collecting from different categories of source which were very current and so we could analyze them and after allowed us to centralize them and to draw some conclusions and discussions after. (<https://www2.deloitte.com>; MATEOC and SEULEAN, 2008; IONESCU, 2020; <https://ec.europa.eu>; The Digital Economy and Society Index (DESI) 2020)

This study reveals presented data and information of the current situation of COVID-19 to achieve the purpose of the study (<https://www.startupcafe.ro>; IONESCU, 2020). Various sources of published literature (IONESCU, 2020; SICOE-MURG, 2017; HALALAU, 2011), case studies (SICOE-MURG, 2017; IONESCU, 2020), and various information from governmental and non-governmental organizations, official reports, and websites were used for the study. (<https://www2.deloitte.com>; <https://ec.europa.eu>; PwC estimates based on OECD PIAAC data; The Digital Economy and Society Index (DESI); <https://www.startupcafe.ro>).

We chose this study because it is current, due to the times we live in, the covid pandemic, we need to understand these times and what their effects are on the world, what we should do and how we can adapt in some areas due to automation.

RESULTS

Between March and July 2020 many people lost their jobs, while the employment rate was also low, reflecting the employers' reluctance to invest in new staff (<https://ec.europa.eu>). In August – September 2020 things began slowly to change, demonstrating a slight compensation when the labor market tried a certain stabilization on a global level. (<https://www2.deloitte.com>) The most unexpected reaction comes from the IT and Software branch, which according to the data published by the World Economic Forum in "Futures of Jobs Report 2020", has an employment rate of -14% in September 2020, which shows, that this branch does not cut jobs at the same rhythm as other industries, nor does it offer employment at the same rate as the year before. (<https://www.startupcafe.ro>, PwC estimates based on OECD PIAAC data, *Table 1., Figure 1.*)

Automation - a risk or a benefit? Artificial Intelligence is considered to be a potential risk for replacing manpower with automatons, but according to a study elaborated by PwC - Will robots steal our jobs? -, „any job losses caused by automation will probably be compensated in the long term by the new jobs created a larger and richer economy, generated by these new technologies.”(<https://ec.europa.eu>)

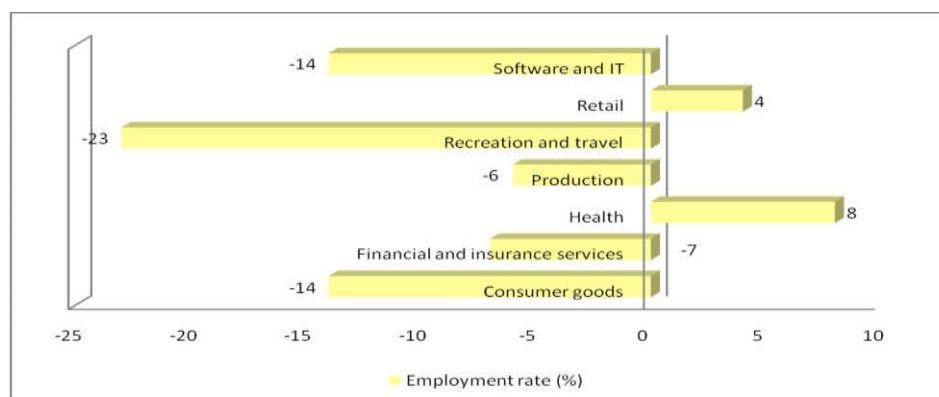


Figure 1. The employment rate on different economic branches

Source: PwC estimates based on OECD PIAAC data

Based on this study we can observe that the potential risk of automation varies in the next years very much among the various industries (HALALAU, 2011). The greatest impact could be felt in the transportation production branches, with automation estimated at 52% and respectively of 45% (IONESCU, 2020). The financial and insurance sector, but also the communication sector seems to be affected rather in a short time than in a long time, whereas the education and the health sector will have the lowest automation rates in long term (MATEOC and SEULEAN, 2008). In the case of insurances, a study elaborated by CompareCamp.com shows that a robot can assist an insurance loss adjuster during the whole process: from the ascertainment of damage to the damage clearing (TĂNĂSESCU, 2009). The repetitive work of an adjuster can thus be reduced by 80% and the operating time with 50 %, which means that there can be ascertained more damages and inferentially more customers will be satisfied. (<https://ec.europa.eu>)

Activity sectors with a high risk of automation

Nevertheless, how can we exploit the changes brought by the pandemic? We live in a world of changes, and either we want or not, we are taken by the herd spirit not having the time to analyze whether the decisions we make are our own decisions or simply we accept to be guided by the instruments we are given to, even we have not asked for them. (<https://www2.deloitte.com>)

That is why it is important to get beyond the conventional approaches and to acquire new abilities, changing the way we make our decisions and keeping informed. Labour force changes rapidly as the new technologies transform the economy and many different and more competences are asked. (HUDEA, 2017; TĂNĂSESCU, 2007)

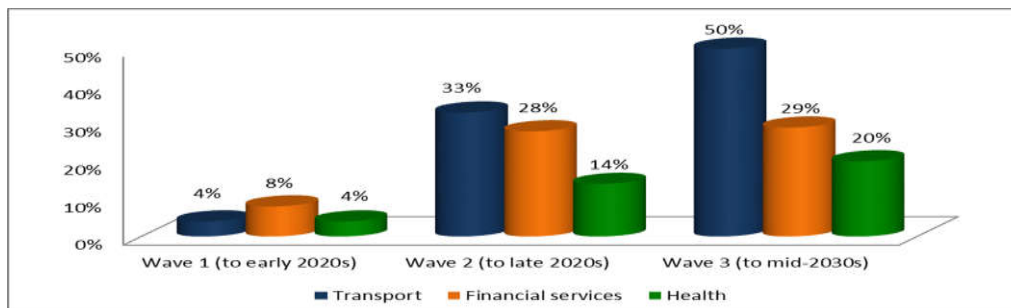


Figure 2. Potential job automation rates by industry across waves

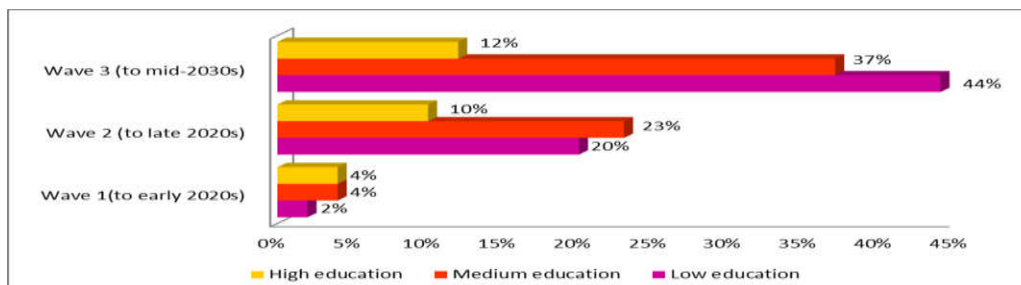


Figure 3. Potential job automation rates by education level across waves

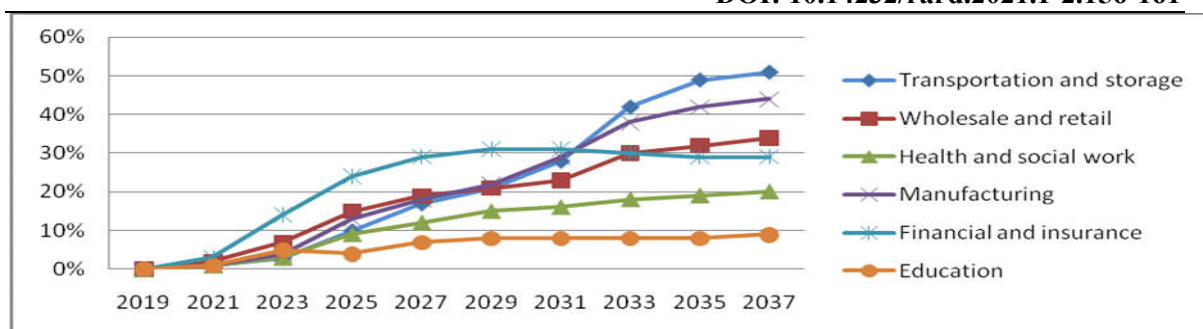


Figure 4. The evolution of the probable impact of automation on jobs in different activity sectors in time

Source: PIAAC data, PwC analysis

At the end of this difficult period for the population, we will notice the emergence of new abilities that will make the world a better place:

» Future education – this ability will allow people to imagine and understand the future because the images of the future will determine our expectations, disappointments, and wish to invest or to change.

» System thinking – presumes a new system thinking, communication and learning mentality, to clarify all patterns, to improve and disseminate the understanding of the problems and to learn how to confront them efficiently.

» Anticipation – this ability calls for learning how to recognize a possible future and to use this increased knowledge to shape our present decisions and actions.

» Strategic prevision – represents the capacity of people, governments, companies, and organizations to understand better the future and the expected changes, as we shall live in a different world as that we are living now. (PwC estimates based on OECD PIAAC data, <https://ec.europa.eu>)

The ranking list of the member states of the European Union (EU) regarding the index Digital Economy and Society in 2020, based on the data of 2019, shows **Finland, Sweden, Denmark, and the Netherlands** have the most advanced digital economies within the EU, followed by Malta, Ireland, and Estonia. Bulgaria, Greece, Romania, and Italy have unfortunately the lowest score. (The Digital Economy and Society Index (DESI) 2020)

In working out this ranking list, the authors have established a scale with points between 0 – 100 points. Each country has got several points under its digitalization. Thus, it was easier to elaborate the ranking list. The only country not present in the ranking list is Ukraine, as it didn't get any points in the category **Using Internet Services**, thus being eliminated from the ranking list. Nevertheless, we should be aware of the fact, that digitalization is not the only factor to generate changes in the labor force market, as there are other factors, which should be taken into consideration as well, such as the aging of the population. (The Digital Economy and Society Index (DESI) 2020)

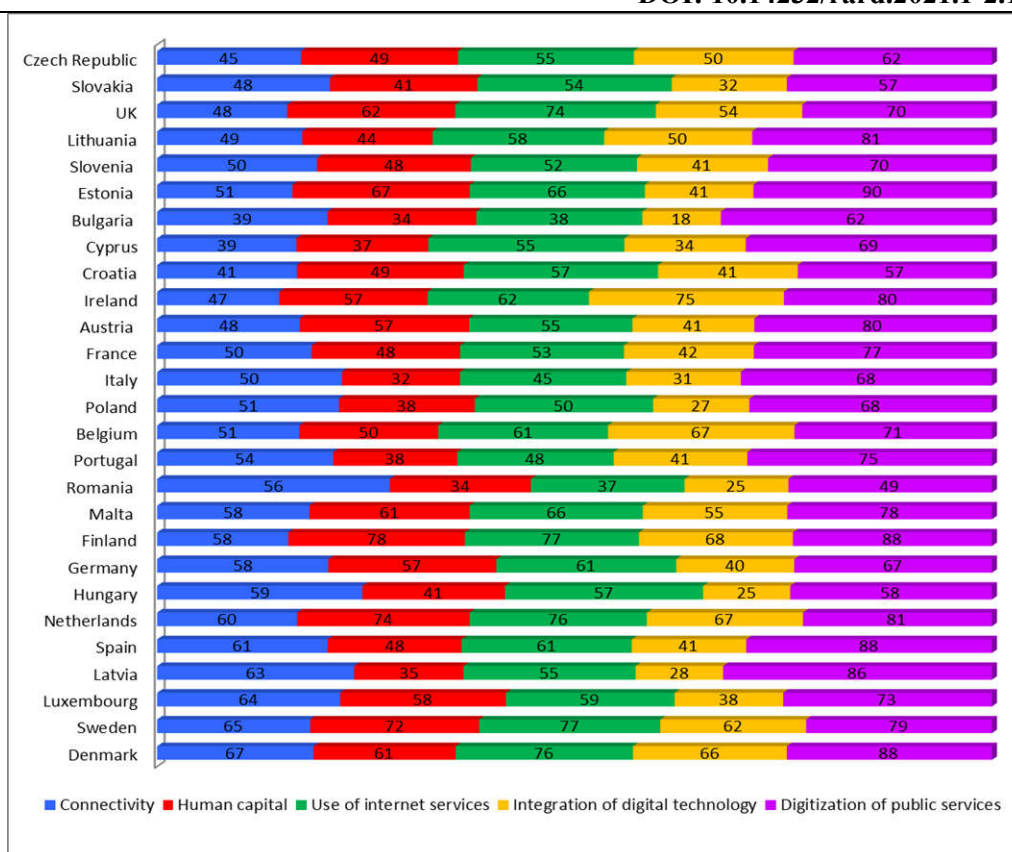


Figure 5. The ranking list of the European Union (EU) member states regarding the index concerning digital economy and society in 2020

Source: The Digital Economy and Society Index (DESI) 2020

The Insurance Industry – a new reality. The insurance industry has known a slight decrease on a global level, but also in Romania as a consequence of the pandemic, where job losses or wage cuttings have triggered a large waiver for health insurance as the greatest part of health insurance was covered by the employers (SICOE-MURG, 2017). This contributed to the increase in the number of insurance holders. Neither did the automotive insurance branch get off lightly, though the damage claims have decreased in the second quarter of the year as a consequence that the number of the car effectively on the road has diminished during the lockdown, the number of new insurance policies has also decreased. As a consequence, the pandemic generated by COVID-19 has demonstrated, that there is a need to think of new future strategies, especially in way of exploiting new working possibilities and how to make use of technology. (The Digital Economy and Society Index (DESI) 2020)

DISCUSSIONS

In the report elaborated by the World Economic Forum, “Future of Jobs Report 2020”, it is estimated that „85 million jobs will disappear, while 97 million new jobs will appear up to 2025, in 26 countries”. This shows us, that the employers’ priority should be employees’ training and development programs, to educate the necessary abilities to confront new challenges. As governments were bound to impose measures to reduce social interaction, the companies needed to adapt and to find new ways of alternative work. Small and medium-sized enterprises (including the micro-enterprises) with low levels of digitalization found it very difficult to offer their staff the possibility of working from

home (teleworking). Even for their managers, this represented a huge challenge. One of the most important obstacles in the digitalization of small and medium-sized enterprises is the levels of digital education among their employees and managers as well. The approach of these deficiencies will be vital in ensuring a robust economic recovery. (The Digital Economy and Society Index (DESI) 2020).

How should Insurance companies act in the future? The Insurance companies worldwide and in Romania as well should be conscious of the fact that the “new normality” will be different from that in the past and that there is a great need for changes and adaptability to confront the challenges brought over by the COVID-19 pandemic. There are already different trends in the labor market, demonstrating that digitalization will be a primordial instrument to pass to a new stage in the labor market. Thus, the use of internet applications or virtual assistance are elements the insurance companies should consider necessary to be developed. Furthermore, the companies should offer their staff training programs to improve their digital knowledge, thus transforming teleworking into a perfect transition. Another challenge brought over by the COVID-19 pandemic will be the re-thinking of jobs, such as that of the insurance broker or the insurance loss adjuster.

These jobs have to be concentrated on the re-qualification of the employees, as a consequence of the automation and digitalization trends existing on the labor market in the fields of insurances. Thus, it is expected that a consequence of the COVID-19 pandemic will be the creation of a much more agile labor force, much better prepared to confront challenges and with a much higher performance index.

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- *** The Digital Economy and Society Index (DESI) 2020
- *** PwC estimates based on OECD PIAAC data

EFFECTS OF THE COVID-19 PANDEMIC ON THE ENVIRONMENT AND PROPOSALS FOR SUSTAINABLE STRATEGIES

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ABSTRACT

The outbreak of the coronavirus pandemic (COVID-19) first occurred in late December 2019 at the Hunan Seafood Market in Wuhan, China, and was declared an international public health emergency in a matter of weeks by the World Health Organization. The coronavirus disease (COVID-19) affects every area of human life, including the environment. Measures taken to control the spread of the virus and the slowdown in economic activities have significant positive effects on the environment. Through this study, the authors intend to track the impact caused by the COVID-19 pandemic on the environment by analyzing the available scientific literature. The study indicates that the pandemic situation significantly improves air quality in various cities around the world, reduces greenhouse gas emissions, reduces water pollution and noise, and reduces pressure on tourist destinations, which can help restore ecological systems. It is noted that there are some negative consequences of the pandemic, such as the increase in medical waste through the use and disposal of disinfectants, masks and gloves but also the burden of untreated waste that endangers the environment continuously. It seems that shortly after the pandemic the economic activities will return and the situation could change. Therefore, this study highlights the potential positive impacts of the pandemic on the environment in the long-term. It is expected that the correct implementation of the proposed strategies can be useful for the global sustainability of the environment.

Keywords: COVID-19, environment, positive effects, negative effects, sustainability

INTRODUCTION

The outbreak of the coronavirus pandemic (COVID-19) first occurred in late December 2019 at the Hunan Seafood Market in Wuhan, China, and was declared an international public health emergency in a matter of weeks by the World Health Organization. The coronavirus disease (COVID-19) affects every area of human life, including the environment (AHMED et al., 2020; RUME and ISLAM, 2020).

In general, the pandemic has caused huge socio-economic disruptions worldwide, which have directly or indirectly affected the environment, such as improved air and water quality, noise reduction and ecological restoration (CHAKRABORTY and MAITY, 2020).

Increased use of personal protective equipment (eg face mask, gloves, gowns, goggles, face shield, etc.) and their accidental disposal creates a burden on the environment. (FADARE and OKOFFO, 2020; RUME and ISLAM, 2020).

In these circumstances, this study intends to explore the positive and negative consequences for the environment in the context of the COVID-19 pandemic and to propose possible strategies as a future orientation for environmental sustainability (BODRUD-DOZA et al., 2020; RUME and ISLAM, 2020).

MATERIALS AND METHODS

This study was conducted by reviewing the available published literature, case studies and various information about governmental and non-governmental organizations in official

reports and websites. This study compiles and presents data and information relevant to the environmental effects of COVID-19 and meets the objectives of the study. The selection criteria for the sources from which we were inspired, were with the thought of topicality, to have the most valid and current sources globally, so from each source we could get some important ideas. In order to carry out the work, we used, in addition to the specialized literature and include books, specialized works (AHMED et al., 2020; RUME and ISLAM, 2020; CHAKRABORTY and MAITY, 2020; FADARE and OKOFFO, 2020; BODRUD-DOZA et al., 2020; BISWAL et al., 2020; SAADAT et al., 2020; YUNUS et al., 2020; LENZEN et al., 2018; PEREIRA et al., 2017; RAHMAN, 2020; VAN DOREMALEN et al., 2020; ZAMBRANO-MONSERRATE et al., 2020; MA et al., 2019) and data of COVID-19 on environmental protection expenses extracted from (EUROPEAN ENVIRONMENT AGENCY, 2020; USEPA, 2016) on the basis of which we made our own interpretations, as presented further. The method of scientific research used was the analisation of the negativ and positive elements of the COVID-19 pandemic. From this alalisis we came to some important conclusions.

RESULTS

Effects of the COVID-19 on the environment

The global disruption caused by COVID-19 has had several effects on the environment and climate. Due to traffic restrictions and a significant slowdown in social and economic activities, air quality has improved in many cities and water pollution has reduced in different parts of the world (RUME and ISLAM, 2020).

Increased use of personal protective equipment (mask, gloves, etc.), their accidental disposal and the production of a huge amount of waste from hospitals have negative effects on the environment (RUME and ISLAM, 2020). Both the positive and negative environmental impacts of the COVID-19 are presented in *Figure 1*.

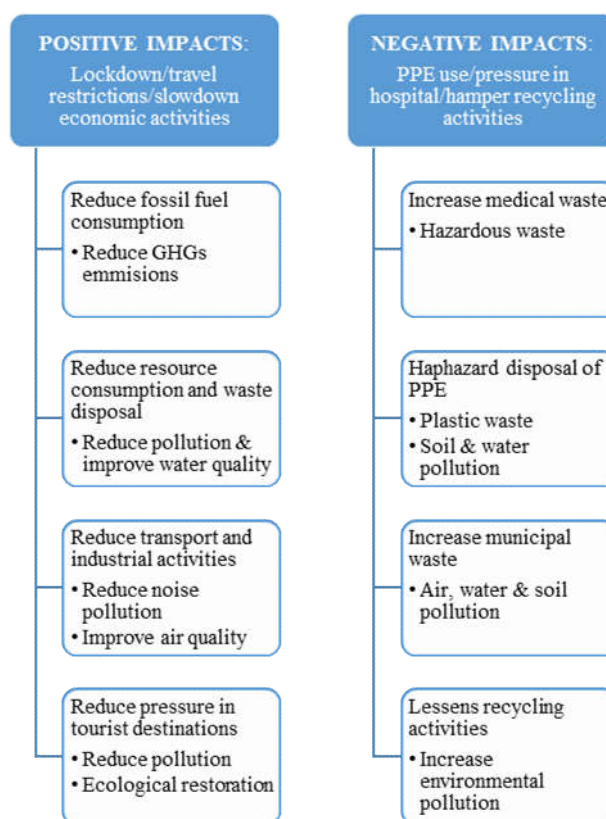


Figure 1. Positive and negative effects of the COVID-19 pandemic on the environment

Positive effects on the environment

As industries, transports and companies closed, it brought about a sharp drop in greenhouse-gas emissions (GHG). Compared to this period of 2019, air pollution levels in New York have decreased by almost 50% due to measures taken to control the virus. It has been estimated that the reduction of N₂O and CO by almost 50% occurred due to the cessation of heavy industries in China (RUME and ISLAM, 2020) NO₂ emissions are also one of the key indicators of the global economy, indicating a decline in many countries due to the recent closures. (BISWAL et al., 2020; SAADAT et al., 2020). NO₂ is emitted from the burning of fossil fuels, 80% of which comes from the evacuation of vehicles (USEPA, 2016). NO₂ is reported to cause acid rain with the interaction between O₂ and H₂O due to which several respiratory diseases occur (USEPA, 2016). The European Environment Agency predicted that due to the COVID-19 blockade, NO₂ emissions had fallen from 30-60% in many European cities, including Barcelona, Madrid, Milan, Rome and Paris (EUROPEAN ENVIRONMENT AGENCY, 2020).

Lower fossil fuel consumption reduces GHG emissions which helps combat the global climate change. According to the International Energy Agency, global oil demand fell by 435,000 barrels in the first three months of 2020, compared to the same period in 2019. (EUROPEAN ENVIRONMENT AGENCY, 2020).

Reducing water pollution

Water pollution is a common phenomenon in a developing country where household and industrial waste is dumped into rivers without treatment (ISLAM and AZAM, 2015).

During the quarantine period, the main industrial sources of pollution decreased or stopped completely which contributed to the reduction of the pollution load (YUNUS et al., 2020).

Ecological restoration and assimilation of tourist places

In recent years, the tourism sector has witnessed remarkable growth due to technological advances and transport networks which contributes significantly to global gross domestic product (GDP). It is estimated that the tourism industry is responsible for 8% of global GHG emissions (LENZEN et al., 2018).

However, places of natural beauty (eg beaches, islands, national parks, mountains, deserts and mangroves) attract tourists. To facilitate and accommodate them, a lot of hotels, motels, restaurants, and bars are built, which consume a lot of energy and other natural resources (PEREIRA et al., 2017). For example, PUIG et al. (2017) calculated the carbon footprint of hotel services on the Spanish coast, and the reported consumption of electricity and fossil fuels shows that two-star hotels have the highest carbon emissions. Moreover, visitors throw away various wastes that affect natural beauty and create ecological imbalance (RUME and ISLAM, 2020). Due to the outbreak of COVID-19 and local restrictions, the number of tourists has decreased in tourist places around the world.

As a result of the restriction, the color of the sea water is changed which usually remains cloudy due to swimming and motor boats. Recently has been reported that due to the reduction of pollution, dolphins returned to the coast of the Bay of Bengal (Bangladesh) and to canals, waterways and ports in Venice (Italy) after a long decade (RAHMAN, 2020).

Negative effects on the environment***Increase in the production of biomedical waste***

Since the outbreak of COVID-19, the production of medical waste has increased globally, posing a major threat to public health and the environment. The collection of samples of patients suspected with COVID-19, the diagnosis and the treatment of a large number of

patients generates a lot of infectious and biomedical waste. For example, Wuhan in China produced more than 240 metric tons of medical waste every day during the outbreak (SAADAT et al., 2020) which is almost 190 m tons higher than in the pre-pandemic period (ZAMBRANO-MONSERRATE et al., 2020). Such a sudden increase in hazardous waste and its proper management has become a significant challenge for the local waste management authorities. According to the recently published literature, it is reported that the SARS-CoV-2 virus can exist for one day on cardboard and up to 3 days on plastic and stainless steel (VAN DOREMALEN et al., 2020). Therefore, hospital-generated waste (eg. needles, syringes, bandages, masks, gloves, used tissue, discarded medicines, etc.) should be properly managed to reduce additional infections and environmental pollution, which is now a concern on a global level. However, experts and responsible authorities suggest the proper disposal and separation of the household organic waste and the protective equipment based on plastic (hazardous medical waste), because the mixing of this waste increases the risk of disease transmission and exposure to virus of sanitation workers (MA et al., 2019).

Production of municipal solid waste and reduction of recycling

The increase in the production of municipal waste (both organic and inorganic) has direct and indirect effects on the environment, such as air, water and soil. Due to the pandemic, quarantine policies in many countries have led to an increase in online shopping for home delivery, which ultimately increases the amount of household waste from shipped packaging materials. However, waste recycling is an effective way to prevent pollution, save energy and conserve natural resources (MA et al., 2019). But because of the pandemic, many countries have postponed waste recycling activities to reduce the transmission of viral infection. For example, the US has restricted recycling programs in many cities (almost 46%), as the government has been concerned about the risk of COVID-19 spreading in recycling facilities. The United Kingdom, Italy and other European countries have also banned infected residents from sorting their waste (ZAMBRANO-MONSERRATE et al., 2020). In general, due to the disruption of routine in municipal waste management, waste recovery and recycling activities, increasing landfills and global environmental pollutants.

Other effects on the environment

Recently, a huge amount of disinfectant is applied on roads, commercial and residential areas to exterminate the SARS-CoV-2 virus. Such widespread use of disinfectants can kill non-target beneficial species, which can create an ecological imbalance (ISLAM and AZAM, 2015). Furthermore, the SARS-CoV-2 virus has been detected in patients with COVID-19 in feces and also in municipal wastewater in many countries, including Australia, India, Sweden, the Netherlands and the USA (AHMED et al., 2020). Therefore, additional measures in wastewater treatment are essential, which is a challenge for developing countries, where municipal wastewater is discharged into nearby bodies of water and untreated rivers (ISLAM and AZAM, 2015; RUME and ISLAM, 2020). China has already strengthened its disinfection process (increased use of chlorine) to prevent the spread of SARS-CoV-2 virus through wastewater. But excessive use of chlorine in water could generate a harmful by-product (ZAMBRANO-MONSERRATE et al., 2020).

DISCUSSION

It is assumed that all these environmental impacts are short term.

Therefore, it is time to establish an appropriate strategy for long-term benefits as well as sustainable environmental management. The pandemic has provoked a global response and unites us to win against the virus. Therefore, we propose some possible strategies for the sustainability of the global environment.

Sustainable industrialization: Industrialization is crucial for economic growth; however, it is time to think about sustainability. For sustainable industrialization, it is essential to move to less energy consuming industries, to the use of cleaner fuels and technologies, and to stronger energy efficiency policies. Furthermore, industries should be built in certain specific areas taking into account that wastes from one industry can be used as raw materials in others.

Using public and green transport: To reduce emissions we need to encourage people to use public transport. In addition, people should encourage the use of bicycles over short distances, and the public bicycle sharing system should be available for mass use, which is not only environmentally friendly but also beneficial to health.

Use of renewable energy: The use of renewable energy can reduce the demand for fossil fuels such as coal, oil and natural gas, which play an important role in reducing GHG emissions. Due to the COVID-19 pandemic, global energy demand is reduced, leading to reduced emissions and increased ambient air quality in many areas. But in order to maintain daily needs and global economic growth, it is not possible to reduce energy demand. Therefore, the use of renewable energy sources such as solar, wind, hydropower, geothermal heat and biomass can meet energy demand and reduce GHG emissions.

Wastewater treatment and reuse: In order to control water pollution, both industrial and municipal wastewater should be properly treated before discharge.

Recycling and reuse of waste: To reduce the burden of waste and environmental pollution, both industrial and municipal waste should be recycled and reused. Therefore, the circular economy or circularity systems should be implemented in the production process in order to minimize the use of raw materials and waste generation.

Ecological restoration and ecotourism: For ecological restoration, tourist places should be closed periodically. Furthermore, ecotourism should be strengthened to promote sustainable livelihoods, cultural conservation and biodiversity conservation.

Changing behavior in everyday life: To reduce our carbon footprint and global carbon emissions, we need to change our behavior in our daily lives, to take locally grown food, to make compost from food waste, to disconnect electronic devices when not in use and to use a bicycle instead of a car for short distances.

Directly or indirectly, the pandemic affects human life and the global economy, which ultimately affects the environment and climate. COVID-19's global response teaches us to work together to combat the threat to humanity. Although the impact of COVID-19 on the environment is short-term, the joint and proposed effort over time can strengthen environmental sustainability and save the earth from the effects of global climate change.

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INVESTIGATION OF WATER SOLUBLE SUGAR CONTENT AND FLAVOUR EVALUATION OF GALA MUST, ROYAL GALA AND PINOVA APPLE VARIETIES

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ABSTRACT

Humankind has known regular consumption of apple since ancient times. The fruits contain several bioactive compounds for human. Nowadays, a lot of breded varieties are in cultivation on the world. There are more than 7,500 known cultivars of apples, resulting in a wide range of desired characteristics. The Gala series apples are one of the most popular and common apples in Hungary in the 21st century. Gala Must was used as the subject of a study to compare the fruit quality of Hungarian Gala Must with Pinova and commercially available Royal Gala apples. By studying the data recorded and samples collected in the orchard, the following points were studied and its cultivation in the Szentes region of Hungary is described: total sugar concentration, firmness, colour of fruits in biological ripening status and opinion of consumers. Based our results the water soluble sugar content of Gala Must 15; Pinova 13.8; Royal Gala 14.1 BRIX%.

Keywords: (*Malus domestica* Borkh.), Gala Must, Pinova, Royal Gala, water soluble sugar concentration BRIX (%)

INTRODUCTION

The apple is (*Malus domestica* Borkh.) one of the most popular fruit in many countries (TANÁCS 2005). The apple found in the scriptures in the Garden of Eden is most likely a pomegranate, which also symbolically contained the 613 commandments of the world (RÓNA 2021). It belongs to genus *Malus* in the *Rosaceae* plant family, sub family *Pomoideae*, which includes crop species such as pear, rose and quince. When cultivated, the size, shape and branch density are determined by rootstock selection and trimming method. Its flowers are white with flushing, about 3 to 5 cm in diameter. Both the pedicel and the calyx have off-white downy (QIAN ET AL. 2006). Most varieties are self-sterile and 5 need to plant pollinator trees. The inflorescence consists of a cyme with 4-6 flowers. Many apples require cross-pollination between individuals by insects (typically bees, which freely visit the flowers for both nectar and pollen); these are called self-sterile, and therefore self-pollination is impossible, making pollinating insects essential (WILSON and ELFING, 2013; HARRISON and HARRISON 2011). Apple fruits have high nutritional value, rich in minerals, vitamins, and calcium, which help metabolize excess salt in the human body (LANTOS, 2008). Many varieties are relatively high in sugar, only mildly acidic, and very low in tannin. Apples provide vitamins A and C, are high in carbohydrates, and are an excellent source of dietary fibre (*Table 1.*) (KOUTSOS and LOVEGROVE 2015). The largest exporters of apples are China, Italy, Chile, the United States, and Poland, while the biggest importers in the same year were Russia, the United Kingdom, Iraq, the Netherlands, and Spain. The world crop of apples averages more than 60 million tons a year, the vast majority of which is produced by China however 500 thousand tons by Hungary (AUGUSTYN 2021).

The aims of our work were:

- the test of total sugar concentration of the ripened Gala Must apple fruits compared with Pinova and Royal Gala varieties in colleration of similar growing technology,
- analysis of the cultivation method,
- flavour assessment and market analysis.

Table 1. Main nutritional components of apples in 100g fresh material

Nutrition	value
iron	0.1 g
magnesium	13.8 g
calcium	10.3 g
vitamin B1	2.4 g
vitamin B2	0.1 g
vitamin K	0.2 g
vitamin E	4.6 mg
vitamin A	3 µg
β-carotene	27 µg
vitamin C	0.1 mg
protein	2.2 µg
fat	0.01 mg
fiber	0.02 mg
total sugar	6 mg
carbohydrates	5 mg
energy	218 kJ

MATERIALS AND METHODS

A study of the Gala must apple variety was carried out in Szentes, Hungary on 2020. It is located in the southern part of Csongrád-Csanád County, in the northern part of the county, east of the Tisza River. The orchard is planted with a large number of 4-8 year old fruit trees of the varieties Red Delicious, Golden Delicious, Pinova and Gala Must varieties.

Climatological data of Szentes

Hungary experiences a continental climate in the east, maritime climate in the west and a Mediterranean maritime climate in the south. In general given the average temperatures and precipitation, it corresponds mostly to a continental climate. That means warm summers and cold winters. The Szentes temperature basically comes down to the following: The average temperatures in May, June, July, August and September are optimal. On average, August is the warmest month but on average, January is the coolest month.

The annual average maximum temperature is 16.0°C. The annual average minimum temperature is 5.0°C. Hours of sunshine in Szentes, basically comes down to the following: average, July has the greatest amount of the sunshine but December has the least amount of one. The rainfall in Szentes basically comes down to the following: June is the wettest month. February is the driest month. Annual average precipitation: 495.0 mm.

The studies material

The orchard was planted with several 4 year old Gala Must apple trees. Three Gala Must and three Pinova were randomly picked in situ at the study site in Szentes. The plants were recorded and photographed, and the site was photographed for pest infestation and environment. Records of nutrient availability and manual handling during planting, fruit set and harvest.

Several fresh Gala Must apples and Pinova apples were collected as raw material for the experiment. Multiple sets of data were collected for comparative analysis. The experiments were carried out using a refractometer to determine the sugar content within the samples. Principle of data collection; Refraction occurs when light enters a medium from one medium to another. The ratio of the angle of incidence sine is a constant value and this ratio is called the refractive index. Fruit and vegetable juices in soluble solids content and refractive index in certain conditions (the same temperature, pressure) is proportional, so the determination of the refractive index of fruit and vegetable juices, fruit and vegetable juices can be derived from the concentration (the amount of sugar).

Studying method

Fruit size measurement: three Pinova and three Gala Must apples were picked at random. Use a tool ruler to measure the diameter of the apples. For subsequent comparative analysis. *Colouring measurement:* three Pinova and three Gala Must apples were picked at random. The red and yellow-green parts of the fruit surface were divided and the proportion of the surface area of the apples was calculated separately for each colour block.

Recorded observations on the profile: two ripe Gala Must apples were selected and cut longitudinally and horizontally using a knife. Record the structure of the sections.

Equipments

The experiments were carried out using a HI 96801 refractometer to determine the sugar content within the samples. The ratio of the angle of incidence sine is a constant value and this ratio is called the refractive index.

- **Nutrient supply in different periods**

The most important period for growing of apple species is from flowering to harvest.

Table 2. Nutrient supply in difference period

Period	nitrogen (kg/ha)	P ₂ O ₅ (kg/ha)	K ₂ O (kg/ha)	micro-elements (kg/ha)
flowering	45	5	15	B, Ca
fruiting	20	20	20	B, Ca
colouring	5	15	45	B, Ca

Planting method

The planting method was intensive cultivation. Round based, spool shaped crown, M9 special rootstock were applicated.




RESULTS

Comparison and analysis of shapes and colours

From the test data we can see that Gala Must has the highest total average sugar content in this batch. One of the Gala Must apples in Group 1 had a very high value. By looking at the source of the sample, the remaining half of the apple and its data, I found that this one apple was more saturated and redder in colour and slightly larger in diameter than the other apples.

Similarly, I looked at the data and the source of the Pinova apple from Group2. However it was not significantly different from the other apples. The skin surface was much rougher and had small brown spots. After comparing the data, the Gala Pinova collected from the research orchard performed better than the Royal gala and Pinova in terms of sugar content. They had better quality (*Table 4*).

Table 3. Characters of the matured apple varieties

Variety name	Gala Must	Pinova	Royal Gala
Origins	Research orchards	Research orchards	Market purchases
Harvest/availability	1/3 of September. Stored until May	3/3 of September. Stored until the beginning of July	1/3 of September. Stored until May
Fruit diameter Average	70-80mm	70-80mm	60-75mm
Coloration rate	bright orange-red with a yellowish base	yellowish base, covered with a 70% distinctive orange-red streak	yellow to orange skin, highlighted with pink to red stripes
Colour	70%+	70%+	70%+
Hardness	normal	hard	hard
Photo			
Ten tasters' vote on colour liking	4	2	4

Comparison and analysis of sugar content of fruits**Table 4.** Sugar content of the apple varieties
Sugar content test

Temperature 22.8°C		Variety name		
Unit °Bx	Number	Gala Must	Pinova	Royal Gala
Group 1	1	16,0	14,8	13,9
	2	15,9	14,3	14,1
	3	15,8	14,5	14,0
	avg.	15,9	14,5	14,0
Group 2	4	14,8	13,0	15,2
	5	14,1	12,7	14,5
	6	14,4	12,8	14,8
	avg.	14,4	12,8	14,8
Group 3	7	14,0	13,9	13,5
	8	14,9	14,1	12,9
	9	14,9	14,0	13,8
	avg.	14,6	14	13,4
Total average		15,0	13,8	14,1

Table 5. Flavour evolution of the fruits

Flavour Evaluation Form Statistics							
Variety name	No.	Colour (avg.)	Sweetness (avg.)	Hardness (avg.)	Fragrance (avg.)	Combined flavours (avg.)	Buy or not (Buy unit person)
Gala Must	1	5	5	4	3	4	5
	2	4	4	3	3	3	4
	3	4	4	4	4	5	8
Pinova	4	4	4	3	4	4	7
	5	3	3	4	3	4	4
	6	3	4	3	4	4	6
Royal Gala	7	4	4	4	3	4	7
	8	5	4	4	4	5	8
	9	4	3	4	3	4	6

Evaluation on a scale of 1-5, the higher the quality of the score the better.
1 - Poor, 2 - Fair, 3 - Average, 4 - Good, 5 - Excellent

DISCUSSION

Our paper focuses on the cultivation and breeding of Gala Must in Hungary, as well as comparing the taste and sweetness ratings of Gala Must, Royal gala and Pinova. Gala apples are distinctive for their sweetness, colour and flavour. These points make it stand out from many other apples. As the share of Gala apples increases, more orchards are willing to grow Gala apples and more farmers are willing to select and cross more new varieties. So the future of Gala apples in Europe should be increasingly promising. In

addition, the apple market should be gradually cleared of low-yielding, low-quality apple varieties. Gradually replace them with high quality apples to complete the market. Tests and data show that Gala Must also has a very high sugar content. Some farms have previously stated in their sales information that Gala Must has a sugar content of between 12 and 14°Bx. In fact, the samples collected were experimentally measured to have higher values. Of course, this is also related to the growing techniques and the local climate. In terms of flavour, Gala Must has a very high sweetness.

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TOTAL SAPONIN CONTENT (TSC) OF DIFFERENT ALFALFA (*MEDICAGO SATIVA* L.) CULTIVARS CULTIVATED IN A FIELD EXPERIMENT

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ABSTRACT

Saponins are secondary metabolites produced by various plants. These compounds have important role in the defence system. The word saponin refers to a group of different chemical compounds. Basically, sugar conjugates of triterpenoids or steroids are called saponins. Triterpene-type saponins are more specific among dicotyledonous plants, while steroid-type saponins are more characteristic of plants belonging to the monocotyledonous taxonomic group. Alfalfa is a large-scale cultivated and foraged fodder plant in Hungary. In the defence mechanism of alfalfa, saponins also play an important role. However, large amount of saponins can be toxic in animal fodder, especially in the poultry farming and piggery. As a dicotyledonous plant, the alfalfa saponins are mainly triterpenoid type. In our study we measure the total triterpenoid saponin content and leaf stem ratio of field cultivated alfalfa cultivars. Samples were collected from a randomized block design experiment, planted in the Demonstration Garden and Arboretum of Institutes of Agricultural Research and Educational Farm, in Debrecen, in 2018. Three different cultivars were investigated, and the samples were collected three different times of the growing season at growing stage of early flowering, for three years (2018-2020.). There was no difference in the total saponin content (TSC) of examined varieties on the average of all measured data, although the sampling time showed significant effect on TSC. Our results attract attention to the fact that ageing of alfalfa stands can cause increase in TSC.

Keywords: Alfalfa, Saponin, Total Saponin Content, TSC

INTRODUCTION

Saponins are secondary metabolites produced by various plants and some inferior animal species. Primarily these compounds play important role in the defence system of plants or – in some cases– animals (e.g. sea cucumber). The term saponin refers to a group of natural compounds consisting of a non-polar aglycone of isoprenoidal origin (so-called genin or sapogenin) and one or more sugar units covalently linked thereto. In case of triterpenoid saponins, based on the number of sugar molecules attached to the aglycone backbone, we can distinguish between mono- and bidesmosidal saponins (AZIZ ET AL., 2019). The properties of their structural elements (polar and non-polar units) cause their soap-like behavior in aqueous solutions. The word saponin is derived from the Latin word “sapo”, which also refers to the ability of compounds to form a stable foam when being shaken in aqueous solution (AUGUSTIN ET AL., 2011). Saponins have a variety of properties: they have sour or sweet taste, they also act as emulsifiers, they have a medicinal and haemolytic effect, and their antibacterial, insecticidal and molluscicidal properties are also known. Due to their properties, they are widely used in the production of beverages and confectionery, cosmetics and pharmacological products (VINCKEN ET AL., 2007). Because of their toxic effects on fish, Australian natives have favoured the use of saponin-containing plants in fishing (MILIGATE – ROBERTS, 1995). Higher saponin concentrations could be observed in plant tissues, which are favoured by various pests and pathogens (WINA ET AL., 2005). Some other factors also have impact on the saponin content of an individual plant. For example the temperature of the environment, the nutrient content of

the soil, the amount of water and light available or even the adjacent plants (SZAKIEL ET AL., 2011).

Alfalfa (*Medicago sativa*) is one of the largest fodder crops grown in Hungary, therefore it is essential to know the various content parameters of the plant. Saponins are one of the secondary metabolites of alfalfa. In alfalfa we can find triterpene type saponins. In the case of alfalfa, several sapogenins have already been isolated (e.g.: medicagenic acid, zanhic acid, hederagenin, etc.)(PECETTI ET AL., 2006). The most common monosaccharide side chains, which can be attached to the alfalfa sapogenins, are galactose, glucose, and rhamnose or could be arabinose and xylose, but these last two are less important (CHEEKE, 1971). Saponins are considered to be an antinutritive factor in alfalfa. Early studies in the 1940's and 1950's suggested a link between alfalfa saponins and ruminant bloating. However, it is concluded that saponins do not contribute to pasture bloat in the case of ruminants (MAJAK ET AL., 1980). In addition, saponins may play a role in reducing methane production in ruminant species (KOZŁOWSKA ET AL., 2019). On the other hand, saponins could be undesirable components or even could be toxic for monogastric animals (PLEGER ET AL., 2019).

In our experiment, we wanted to find out which cultivar of the 3 observed (Tápiószelei, Hunor-40, Danubia) has the highest total saponin content (TSC) and whether the time of harvest has an impact on the TSC.

MATERIALS AND METHODS

Samples were collected at different times of each year (2018, 2019, 2020) from a randomized block design experiment, planted in the Demonstration Garden and Arboretum of Institutes of Agricultural Research and Educational Farm, in Debrecen, in 2018. In the first year there were 2 sampling dates, in the second and third years 3-3 sampling were performed. For the quantification of total saponin content we used the method developed by OLESZEK AND STOCHMAL (2002). As a first step, samples were dried at 65 °C then the samples were ground. In the solid phase extraction part 1 gram of each sample was used. 10 ml of 70% methanol was added to the samples and then the samples were shaken for one hour period. After that the samples were filtered using filter paper. Thereafter the filtrates were evaporated until 2-3 ml of aqueous phase remained in the evaporating flasks. The samples were then loaded onto C18 cartridges. After the sample diffused into the cartridge, the following was passed through it: 10 ml of distilled water, 5 ml of 40% methanol, 5 ml of concentrated methanol. The last methanol phase was collected in evaporating flasks and evaporated to dryness. The dry samples were collected with 1 ml of concentrated methanol.

The extraction procedure was followed by measurement with a photometer. The procedure we used was developed by LE ET AL. (2018). 0.025 ml was used from the previously collected samples. The samples were placed in a 65 °C water bath for 5 minutes to allow the methanol to evaporate. 0.5 ml of 4% ethanolic vanillin solution and 2.5 ml of 72% distilled aqueous sulfuric acid solution were added to the samples and then the samples were placed in a 60 °C water bath for 15 min. Finally, the samples were photometrized at the wavelength of 560 nm against a blank solution which solution contained 0.5 ml of 4% ethanolic vanillin solution and 2.5 ml of 72% distilled aqueous sulfuric acid solution. A calibration line using aescin was created previously and from the equation of the calibration line we deduced the total saponin content of the samples.

Statistical analyses were carried out by applying SPSS 23.0 version. One-way and two-way ANOVA were used, the groups were separated with Duncan test.

RESULTS

There was no difference in the TSC of examined varieties on the average of all measured data (Hunor 40: $0,37 \pm 0,05 \text{ m m}^{-1} \%$; Tápiószelei 1: $0.34 \pm 0.04 \text{ m m}^{-1}\%$; Danubia: $0.39 \pm 0.06 \text{ m m}^{-1}\%$). According to the two-way ANOVA, from the given factors: variety, sampling time and their interaction, only the sampling time showed significant effect on TSC (sig. Variety: 0.800; Sampling: 0.020; Variety x Sampling: 0.166).

Table 1. Effect of sampling time on alfalfa's TSC ($\text{m m}^{-1} \%$; $\pm\text{SE}$) on the average of all varieties' data; (n=12)

Sampling time	TSC
2018.08.29. - late summer	0.30 ± 0.06^{ab}
2018.10.18. - autumn	0.30 ± 0.04^{ab}
2019.06.13. - early summer	0.31 ± 0.07^{ab}
2019.08.15. - late summer	0.15 ± 0.05^a
2019.10.01. - autumn	0.32 ± 0.06^{ab}
2020.05.14. - spring	0.39 ± 0.09^b
2020.08.06. - late summer	0.44 ± 0.09^b
2020.09.10. - autumn	0.69 ± 0.09^c

*Letters in the table indicate different groups.

It can be concluded that the lowest TSC, on the average of the examined varieties was measured in case of the samples collected on the 15th of August, 2019, and the highest was measured in the samples collected on the 10th of September, 2020 (Table 1).

There was no correlation between the season of the year (spring, early summer, late summer, autumn) and the measured TSC (Pearson correlation coefficient: 0.084).

Table 2. Effect of sampling times on TSC ($\text{m m}^{-1} \%$; $\pm\text{SE}$) of different examined varieties (n=4)

Sampling time / TSC	Hunor 40	Tápiószelei 1	Danubia
2018.08.29. – late summer	0.20 ± 0.08^a	0.44 ± 0.12^b	0.25 ± 0.08^{ab}
2018.10.18. - autumn	0.30 ± 0.06^a	0.27 ± 0.04^{ab}	0.33 ± 0.09^{ab}
2019.06.13. – early summer	0.40 ± 0.14^{ab}	0.34 ± 0.14^{ab}	0.18 ± 0.02^a
2019.08.15. – late summer	0.19 ± 0.06^a	0.06 ± 0.01^a	0.22 ± 0.19^a
2019.10.01. - autumn	0.23 ± 0.06^a	0.49 ± 0.15^b	0.24 ± 0.05^{ab}
2020.05.14. - spring	0.53 ± 0.23^{ab}	0.49 ± 0.08^{ab}	0.32 ± 0.11^{ab}
2020.08.06. - late summer	0.40 ± 0.06^{ab}	0.27 ± 0.08^{ab}	0.64 ± 0.23^{bc}
2020.09.10. - autumn	0.70 ± 0.15^b	0.53 ± 0.20^b	0.87 ± 0.14^c

*Letters in the table indicate different groups.

Examining the effect of sampling time on TSC of varieties separately, the next findings can be concluded (*Table 2*):

In case of Hunor 40 variety there were no differences amongst the measured TSC in the given years, but in the implied years differences were found thanks to the ageing of the stand.

Varieties Tápiószelei 1 and Danubia showed extreme low TSC on the late summer of 2019. The effect of ageing was no detectable in the measured data of Tápiószelei 1 variety.

In case of Danubia variety the ageing of the plant stand also caused increase of TSC, as in case of variety Hunor 40.

Insofar that we compare the TSC of different experimental years on the average of all data of the examined varieties, it can be concluded that lower TS-contents were characteristic to the years 2018-2019. In 2020 higher TS-contents were measured (2018: 0.30 ± 0.03^a m m⁻¹ %; 2019: 0.26 ± 0.04^a m m⁻¹ %; 2020: 0.51 ± 0.06^b m m⁻¹ %; \pm SE) (n=24-32).

DISCUSSION

As water supply of the experimental plants was adequate from year to year, by applying irrigation, the background of the differences can be the ageing of the experimental plants and the temperature differences of examined years. It is possible that the older plants were under greater pressure due to pathogens and pests. Increased saponin synthesis may be associated with plant defence.

In the third year of the experiment, the highest total saponin levels were measured (2018: 0.30 ± 0.03^a m m⁻¹ %; 2019: 0.26 ± 0.04^a m m⁻¹ %; 2020: 0.51 ± 0.06^b m m⁻¹ %). This finding may suggest that increasing saponin content is associated with plant aging.

The measured TS-contents correspond to other investigations. Earlier results presented higher TS-contents (0,8-2,0 m m⁻¹ %), (PEDERSEN AND WANG, 1971; MAJAK ET AL., 1980). Newer publications, like KOZŁOWSKA AND CO-WORKERS (2020) presented 0.07 and 0.33 m m⁻¹ % TSC of ten alfalfa cultivars.

Although no correlation was found between the sampling season and the total saponin content of the samples based on statistical evaluation in our experiment, the literatures found that total saponin content is low in spring and autumn and peaking in mid-summer (HOWARTH, 1988; PECETTI ET AL., 2006).

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