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TWO ANCIENT WHEAT SPECIES, POSSIBILITIES FOR THE PRODUCTION OF EINKORN AND EMMER IN ORGANIC FARMING

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Abstract: The diploid einkorn (*Triticum monococcum ssp. monococcum*) and the tetraploid emmer (*Triticum turgidum ssp. dicoccum*) have been produced in smaller areas − primarily in poor quality arable lands in the mountains − in Hungary until the 19th Century. Nowadays these two ancient glumaceous wheat species came into the limelight again, as they could be possibly used mostly in organic farming. The aim of our research was to expand the currently available – and fairly incomplete − knowledge about the organic production of einkorn and emmer. We compared the plant development, the weed control characteristics, the yield level and the effects of soil quality in the case of the einkorn variety called „Mv Alkor" and the emmer variety called „Mv Hegyes" in field experiments. According to our results covering one vegetation period, it can be stated that both species could be successfully used in organic farming even in areas with lower production potentials, as their production technology can be easily integrated into this kind of system. Especially, the general weed and ragweed control features of einkorn proved to be very beneficial.
Keywords: einkorn, emmer, organic farming, poor quality arable lands, the general weed and ragweed control features of einkorn

1. INTRODUCTION

Einkorn (*Triticum monococcum ssp. monococcum*) and emmer (*Triticum turgidum ssp. dicoccum*) have been introduced into the Carpathian Basin by agricultural tribes in the Neolithic age [Gyulai 2009]. Today einkorn is still produced in Europe, mostly in small, isolated mountainous regions and basins. At the same time its production area is growing in Germany, Switzerland and Italy due to the spread of organic farming. In the second half of the 20th century einkorn was produced in some extremely poor mountainous soils of Hungary as well [Koháry 2003, Gyulai 2009]. On the other hand, the production of emmer can be found only in the mediterranean regions and in North-Africa at the present. In the Carpathian Basin it was mostly produced in mountainous areas, and its range was rather scattered in Hungary [Koháry 2003, Kovács 2009a].

During the comparison of the chemical composition of spicate grains it was found that the average raw protein content of glumaceous wheat species (einkorn, emmer, spelt) was 50% higher than in the case of common wheat, in addition their raw fat content was 30% higher as well. In the case of einkorn and emmer almost 20% of the dry material of the seed grain is composed of protein [Körber-Grohne and Küster 1989]. The vitamin pro-A and vitamin E content of the improved einkorn strains is higher than in the case of winter wheat. Some of the strains have fairly high gluten content, while others contain no gluten at all [Kovács 2009b]. Einkorn has high lysine and other essential amino acid content besides its high microelement level, but it contains only a small amount of carbohydrates. It can be used in the form of germs, in soups and vegetable dishes, but mush, cakes, pasta and bread can be also made from it [Gyulai 2002, Koháry 2003, Gyulai 2009]. Also there some attempts to use it in brewery activities [Hegyesné Vecseri and colleagues 2011]. Its straw can be used for making roofs or for tying [Ortutay 1982], but this is the raw material of the very characteristic straw hats of Kalotaszeg as well. Neither the straw of einkorn nor the straw of emmer can be used as fodder [Gyulai 2009].

The cold resistance and the drought resistance of einkorn and emmer are excellent, and both plants can be produced on sandy soils too. In addition, they are resistant to most of the pests and diseases. However is not advised to produce einkorn directly after maize, as during its initial development phase it is susceptible to the fungal disease caused by fusarium. Both einkorn and emmer can excavate and utilize nutrients very efficiently, therefore it is not advised to fertilize them even in the case of poor quality soils. On soils that are rich in nitrogen they are susceptible to lodging in rainy years. In the case of poor quality soils it is advised to perform fertilization with organic manure two years before the production of einkorn. According to the observations, einkorn does not need phosphorous or potassium fertilization. It is also beneficial that during sowing the biological substances of the chaffs of einkorn and emmer protect the germinating seeds from the pests. In the case of einkorn 2.5 million germs, while from emmer 2.5-3 million germs are advised to be sown in one hectare of land. Wild animals mostly prefer einkorn as food and shelter. Einkorn and emmer ripe 3 weeks later than winter wheat, therefore they are usually harvested at the end of July in the stage of yellow ripeness. The head of einkorn breaks down easily when it is overripe. In the case of regular ventilation both einkorn and emmer can be stored for long with their chaffs on [Kovács 2009b, Kovács 2010, Megyeri and colleagues 2011].

Einkorn tillers very well, it has excellent weed control features, and due to its allelopathic effects it hinders the emergence and the development of weeds, especially after shooting [Kovács 2009b]. According to the results of field experiments, weed infestation significantly decreased on areas sown with einkorn, and in the case of ragweed even 100% green mass and size reduction was observed in some cases. The direct germination inhibitor feature of einkorn was also proven by laboratory experiments [Bartl and Üveges 2005].

In the case of spelt a huge amount of production experience is already available for organic farmers in Hungary, but much less information can be found about einkorn and emmer which came into the limelight in the international grain market only in the last years [Kovács 2010]. Although there is already one einkorn variety ("Mv Alkor") and one emmer variety ("Mv Hegyes") in the Hungarian variety list, experience about their production is still missing. The aim of our research was to expand the currently available knowledge about their production in organic farming.

2. METHODS

We carried out our experiment in the fields of the Babatvölgy Organic Educational Farm belonging to the Szent István University having Ramann-type brown forest soil. We sowed 0.7 hectare of einkorn and 0.7 hectare of emmer directly next to each other after a more years old weedy alfalfa preceding crop. The agricultural operations performed before sowing included the spreading of manure (from extensive farming) in the amount of 23 t/hectares, medium-deep ploughing, discing after ploughing and seedbed making with a combinator. The einkorn variety called "Mv Alkor" and the emmer variety called "Mv Hegyes" were sown on 3rd November 2010. The seeds had their chaffs on, and they were not coated. We used organic einkorn seeds, while the emmer seeds originated from a farm being in the transition period. There were no agricultural operations (e.g. weed control, fertilization, plant protection measures) in the vegetation period. The crops were harvested on 14th July 2011.

6-6 sampling parcels were designated in both wheat stocks. Each sampling parcel was 4 x 1 m² large, therefore data recording was carried out in 4 repetitions in each parcel. We examined the number of plants two times in each parcel by counting the plants in 8 x 1 flowmeter (in 2-2 rows per repetition). We recorded the height of the plants four times, and we counted the number of shoots two times with 2-2 measuring per repetition. Weed-cover was recorded once by using the Balázs-Ujvárosi monitoring method [Ujvárosi 1973] in the 4 x 1 m² large areas of the sampling parcels. The yield was harvested in four repetitions from the parcels, and then its weight (in g/m²) and the weight of 1000 spiculas were measured.

We also took soil samples from the depth of 0-30 cm keeping the same distances between the individual sampling parcels in the case of einkorn and emmer as well. The samples were analysed by the laboratory of the Department of Soil Science and Agrochemistry in the Faculty of Agricultural and Environmental Sciences of the Szent István University.

For the laboratory analysis of the fungi colonization of the seed grains we randomly selected 10-10 seeds from the yield samples, we degerminated their surfaces (by shaking them in 1% chloramine-T solution for 5 minutes and in 70% ethyl alcohol for 1 minute), then we cut them into two parts lengthwise under aseptic conditions, and finally we put them on agar-agar turning the freshly cut side down. For the propagation of toxigenic fungi we used three types of agar-agar at the same time: potato extract-glucose agar-agar as general mycological substrate, PCNB-rose bengal agar-agar as fusarium selective substrate and peptone agar-agar containing malachite green oxalate. The bed morphologic and microscopic morphologic characteristics of the isolated strains were identified based on the analysis of the cultures grown on the potato extract-glucose agar-agar and the microcrystalline cellulose agar-agar. Their identification was carried out with state of the art systems [Seifert and colleagues 2011] until the genus level by using the above mentioned characteristics.

During the evaluation of the results of the measurement we used the statistical probes of the mean values, variance and regression analysis [Sváb 1981].

3. RESULTS

3.1. Soil characteristics of the sampling parcels

Regarding the physical soil characteristics of the experimental site, sampling parcel nr. 1 is situated on sandy loam soil, while all the other parcels are based on sandy soils. The chemical reaction of the soil is alkalescent everywhere, except for parcel nr. 5 (where it is slightly acidic) and parcel nr. 6 (where it is acidic). Parcel nr. 5 and 6 contain no lime, parcel nr. 1 has high lime content, while the other parcels contain only a small amount of lime. The humus content is the highest in parcel nr. 1 and 2, therefore the availability of nitrogen is the highest on these areas. The availability of phosphorous is low in the case of parcel nr. 1, 5 and 6, while it is average on the other parcels. The availability of potassium is very low in all the parcels (see Table 1). Parcel nr. 5 and 6 are the least favourable ones due to their unfavourable physical soil characteristics, acidic chemical reaction, low humus content and the low availability of nitrogen, phosphorous and potassium.

Table 1.: Soil characteristics of the sampling parcels (Gödöllő, 2011)

Parcel	Soil characteristics								
	K_A	pH (H_2O)	pH (KCl)	$CaCO_3$ %	Humus %	P_2O_5 (ppm)	K_2O (ppm)	NH_4-N (ppm)	NO_3-N (ppm)
1.	31	7,88	7,28	10,20	2,95	102	57	2,6	3,4
2.	30	7,81	7,27	3,74	2,66	155	83	2,7	3,4
3.	30	7,78	7,25	2,11	1,23	223	87	3,8	2,4
4.	29	7,34	7,10	0,20	1,64	245	115	2,4	2,1
5.	26	6,19	5,88	0,00	1,02	80	71	2,2	1,3
6.	25	5,25	4,48	0,00	1,16	59	84	2,0	1,1

3.2. Plant analyses

If sowing is carried out in the optimal time (between 1-20th October), the advised germ number for sowing is 250 pieces/m² in the case of einkorn, and it is 250-300 pieces/m² in the case of emmer. On

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the other hand, 22 days after sowing (26th November, 2010) the average number of plants was 210 pieces/m^2 in the case of einkorn, while it was 168 pieces/m^2 in the case of emmer (see Figure 1). During the spring measurement (22nd March, 2011) the number of plants was found to be lower compared to the plant number registered before winter in the case of both wheat species. The winter reduction reached 22% in the case of einkorn, while it was 19% in the case of emmer. There was a significant difference between the number of plants per flowmeter in the case of both wheat species. The lowest number of plants was 12 pieces/flowmeter in the case of einkorn and 4 pieces/flowmeter in the case of emmer, while the highest number of plants was 37 pieces/flowmeter in the case of einkorn and 63 pieces/flowmeter in the case of emmer. According to the standard deviation results, this time the stock of einkorn was more even than the stock of emmer. In spring the average plant number was 165 pieces/m^2 in the case of einkorn, while it was 137 pieces/m^2 in the case of emmer. Both numbers were much lower than the desired one, which meant that both stocks were rare.

The observed low number of plants can be traced back to several reasons. Since we did not have former experience about the sowing of einkorn and emmer, a lower number of germs have been sown than desired due to the inappropriate adjustment of the sowing machine. In addition, during sowing the sowing ducts did not transport the seeds evenly, spiculas got stuck in the duct quite often, this way causing stoppage. Consequently, some of the coulters did not sow, or after the ceasing of stoppages more spiculas have been sown. Furthermore, sowing was performed after the optimal sowing time, only on 3rd November. Although the cold resistance of both wheat species is excellent, the weakly developed plants – having only 1-3 leaves before the winter period – could have been damaged by the cold winter weather.

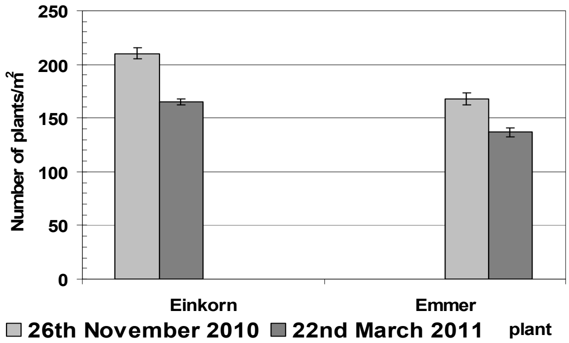

Figure 1.: The number of emerged einkorn and emmer plants

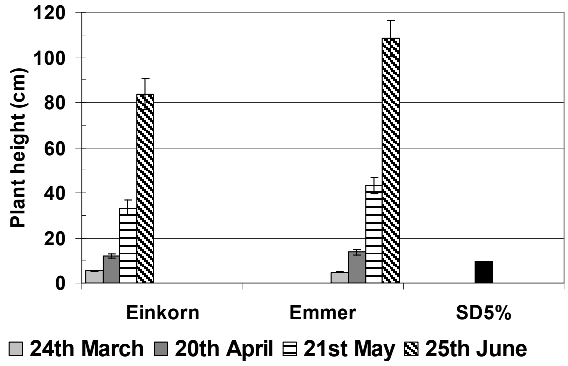

Figure 2: The height of einkorn and emmer plants in the different periods ($SD_{5\%}$ 9.6 cm)

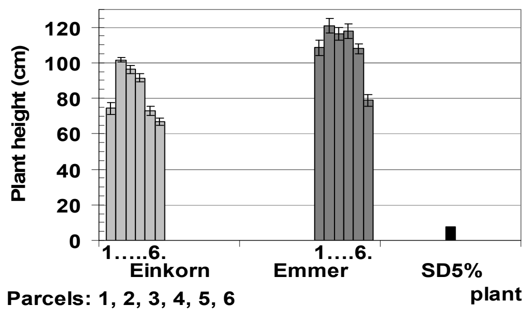

Figure 3.: The height of einkorn and emmer plants during growing heads in the different parcels ($SD_{5\%}$ 4.1 cm)

Under our experimental conditions none of the wheat species reached the plant height which was stated in the variety descriptions (120-130 cm for einkorn and 130-150 cm for emmer) (see Figure 2). During the measuring performed in the tillering phase (in March and April) the two wheat species were equally developed, but from shooting emmer was significantly higher, and in the last phase when the plants grew heads emmer (108 cm) proved to be 24 cm higher than einkorn (84 cm) on the average.

The differences between the soil characteristics of the different sampling parcels became gradually visible through the height of plants from the beginning of shooting. During the period of growing heads the highest plants were found in parcel nr. 2, 3 and 4, while we the significantly shorter ones grew in parcel nr. 1, 5 and 6 in the case of both varieties (see Figure 3).

Close to the end of the tillering phase (20th April) there was no significant difference between the number of shoots per plant when comparing einkorn and emmer to each other (see Figure 4). After growing heads (25th June) the average productive shoot number of einkorn (7 shoots/plant) was significantly higher than in the case of emmer (3.4 shoots/plant) The difference between the shoot numbers registered in the two measuring periods was not significant in the case of einkorn, but in the case of emmer the number of shoots growing heads was significantly lower compared to that of registered during the tillering phase. According to the data of the sampling parcels, in the case of einkorn the highest number of productive shoots (8 pieces/plant) was found in parcel nr. 2, 3 and 4, while in parcel nr. 1, 5 and 6 significantly lower values (6 pieces/plant) were measured. In the case of emmer the differences were not significant, except for parcel nr. 6, where the measured shoot number (2.4 pieces/plant) was significantly lower than the shoot number registered in parcel nr. 3 and 4 (4 pieces/plant).

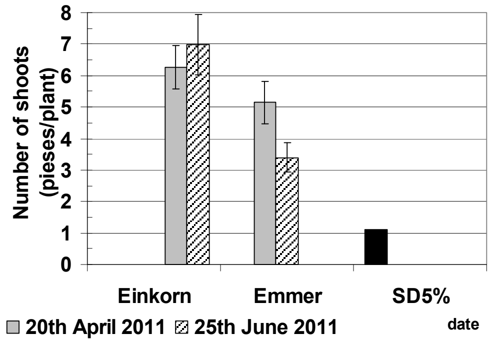

Figure 4.: The number of einkorn and emmer shoots ($SD_{5\%}$ 1.1 piece)

The length of heads on the productive shoots ranged between 4-9 cm in the case of einkorn and 4.6-9.5 cm in the case of emmer. The heads of emmer (7.6 cm) were significantly longer than the heads of einkorn (5.9 cm) ($SD_{5\%}$ 0.8 cm), and the difference was 1.6 cm on the average. Based on the data of the different parcels, the significantly largest einkorn heads grew in parcel nr. 3, while the significantly smallest emmer heads grew in parcel nr. 6.

3.3. Weed infestation and the number of pests

According to the result of the weed monitoring carried out on 21st May 2011, weed cover was much lower in the stock of einkorn (7% on the average) than in the stock of emmer (16% on the average). Although the same species were found in the case of both wheat species, their cover was different, and it varied parcel by parcel. The highest weed cover was registered in parcel nr. 6, whose stock had the shortest plants and the smallest number of productive shoots. This way the weed control effect of these plants could not reach the optimal level (see Figure 5). The only representative of the G1 life form was wheat-grass (*Elymus repens*). From T1 weed species we found shepherd's purse (*Capsella bursa-pastoris*), ivy-leaved speedwell (*Veronica hederifolia*) and henbit dead nettle (*Lamium amplexicaule*). From T2 weed species silky bent grass (*Apera spica-venti*) and larkspur (*Consolida regalis*) were observed. T3 weed species were represented by wild mustard (*Sinapis arvensis*) and wild radish (*Raphanus raphanistrum*). Weed species having T1, T2 or T3 life forms covered 1% of the area of einkorn on the average, while their cover reached 3.7% in the case of emmer.

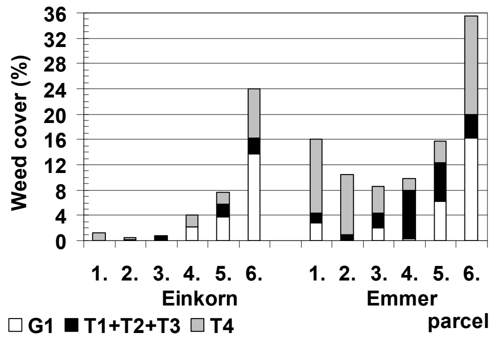

Figure 5.: Weed cover in the stocks of einkorn and emmer (Gödöllő, 21st May 2011)

The cover of T4 weed species was more significant (2.1% in einkorn, 7.7% in emmer on the average). Their most important representatives were ragweed (*Ambrosia artemisiifolia*) and common knotgrass (*Polygonum aviculare*), but with very low coverage level common lambsquarters (*Chenopodium album*), hemp (*Cannabis sativa*) and scentless mayweed (*Tripleurospermum inodorum*) were found as well (see Figure 6).

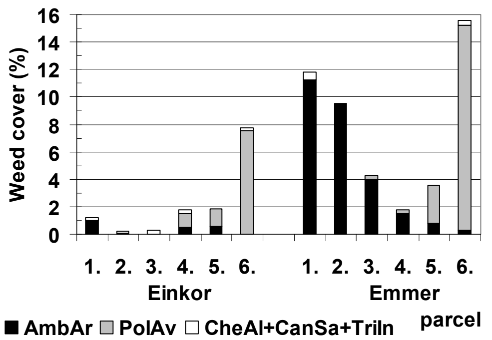

Figure 6.: The cover of T4 weed species in the stocks of einkorn and emmer (Gödöllő, 21st May 2011)

The cover of ragweed is particularly interesting, as it is very low everywhere in the parcels of einkorn, and reached 1% only in parcel nr. 1. At the same time, its coverage value exceeded 1% in the first four parcels of emmer, while it exceeded 9% in parcel nr. 1 and 2. The data of our measurement seem to confirm the findings of other former observations about the allelopathic effects of einkorn against weeds and ragweed.

During production diseases were not observed in the parcels at all. From the pest species cereal leaf beetle (*Lema melanopa*) imagos were found in April, but they did not cause any damages that time or even later, which could be traced back to the presence of hairs that are sparsely situated on the shoots and the leaves. In June we found some plant bugs, aphids and before harvest also grain beetles (*Anisoplia austriaca*) in some parts of the area, but they did not cause significant damages.

Our experimental site was surrounded by forests from two sides, therefore boars and deers visited the parcels several times in the tillering and shooting phases. They mostly damaged the plants by treading and hiding in them rather than by eating them. After growing heads there were no game damages due to the awned heads of einkorn and emmer.

3.4. Yields

Although the average yield level per square meter was higher in the case of the einkorn (182 g) than the values registered in the case of emmer (129 g), the difference is not significant ($SD_{5\%}$ 78.5 g). The average weight of 1000 spiculas was two times bigger in the case of emmer (95.4 g) than in the case of einkorn (45.9 g). The reason for this significant difference is that the spiculas of emmer contain two grains of seed, while the spiculas of einkorn contain only one, and they contain two grains only rarely. We found significant differences between the yield levels of the different parcels. The different soil characteristics of the individual parcels offered a great opportunity to analyse the environmental demand of the two ancient wheat species. In the case of einkorn the significantly highest results were registered in parcel nr. 2, 3 and 4, while the lowest results were found in parcel nr. 5 and 6. In the case of emmer a significantly outstanding yield was harvested in parcel nr. 3, while the lowest yield was observed in parcel nr. 6. (see Figure 7). Calculating with the characteristics of the experimental site the estimated yield level is about 1.5-2.2 t/hectare in the case of einkorn, while it is 1.0-1.6 t/hectare in the case of emmer (at the level of P=5%).

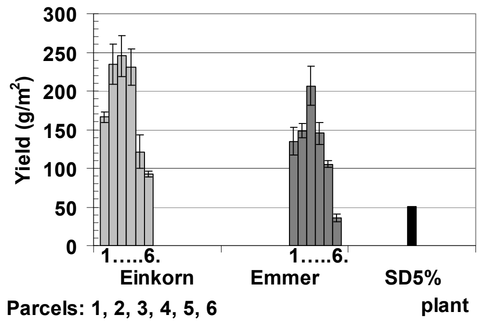

Figure 7.: The yield level of einkorn and emmer by parcels ($SD_{5\%}$ 78.5 g)

According to the analysis of the connection between the yield levels and the soil characteristics of the experimental parcels it can be stated that the chemical reaction of the soil and the changes of the P_2O_5 and nitrogen content (especially NO_3-N) influenced the yield level in the case of both wheat species. The acidic chemical reaction of the soil and the lower availability of phosphorous and nitrogen lead to lower yield levels (see Figure 8). These connections can be regarded as strong, and they are significant at the level of P=5%.

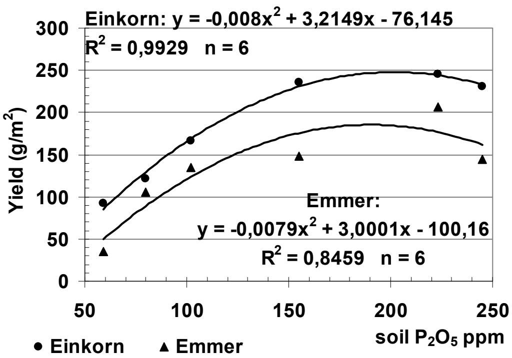

Figure 8.: Connection between the P_2O_5 content of the soil and the yield

There was a positive connection between the height of the plants having their heads and the yield levels in the case of both wheat species, which was fairly strong in the case of einkorn (r=0.9517, significant at the level of P=1%), and was strong in the case of emmer (r=0.8692, significant at the level of P=5%). This result can be traced back to the fact that the plants could grow stronger in parcels having better soil characteristics, which in turn affected the yield.

In the case of einkorn there was a fairly strong connection between the number of productive shoots and the yield level (r=0.9837, significant at the level of P=0.1%) (see Figure 9). The connection between these two factors was also evincible in the case of emmer, but it was not as determinative as in the case of einkorn (r=0.8526, significant at the level of P=5%).

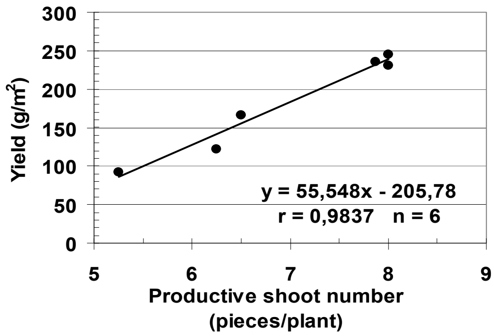

Figure 9.: Connection between the productive shoot number and the yield level in the case of einkorn

We found a fairly strong connection between the length of the head and the yield level in the case of emmer (r=0.9710, significant at the level of P=1%), but we did not find a determinative connection in the case of einkorn (r=0.8021) (see Figure 10). In the case of emmer some kind of connection was also found between the weight of 1000 spiculas and the yield level (r=0.8502, significant at the level of P=5%), which was not evincible in the case of einkorn.

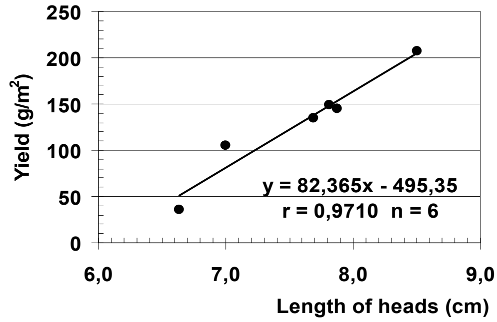

Figure 10.: Connection between the length of heads and the yield level in the case of emmer

3.5. The fungi colonization of the seed grains

As we found no traces of pathogen diseases in the experimental stock, we focused on the presence of the potentially toxic *Fusarium* and *Aspergillus* fungi genera during the fungi colonization analysis of the ripen seed grains (see Table 2). In the seed grains of einkorn, emmer and winter wheat the number of bed forming units from the *Fusarium* genus was 3, 4 and 8 pieces/10 grains respectively. In the case of the ancient wheat varieties the found fungi beds (7 beds altogether) were formed by several species, while in the seed grains of winter wheat *Fusarium graminearum* – capable of producing DON toxin as well – and *Fusarium proliferatum* – being able to produce *fumonisin* – were present with the same ratio. We found 1 piece of *Aspergillus* in einkorn, 4 pieces in emmer and 6 pieces in winter wheat. The limited number of processed samples does not allow us to draw strict conclusions, but since the propagated isolatums contained *Aspergillus niger* (being able to produce several kinds of toxins), *Aspergillus ochraceus* (capable of producing ochratoxin) and the most typical aflatoxin producing *Aspergillus flavus* as well, during the manipulation, storage and processing of the grains attention should be paid to the risk of potential toxin production. It is true even if einkorn contained only a very small amount and emmer contained less *Aspergillus* than winter wheat which was produced under the same conditions, and if it can be assumed that fungi colonies are located primarily in the epidermis of the seed grains.

Table 2.: The occurrence of mould groups in ripen seed grains (Gödöllő, 2011)

Species	Level of colonization (CFU/10 seed grains)		
	Einkorn	Emmer	Winter wheat*
Fusarium moniliforme	0	0	5
Fusarium graminearum	0	0	3
Fusarium sp.	3	4	0
Aspergillus flavus	1	3	5
Aspergillus niger	0	0	1
Aspergillus versicolor	0	1	0
Acremonium sp.	4	3	1
Alternaria sp.	0	0	4
Cladosporium sp.	1	1	4
Mucor sp.	2	3	8
Paecilomyces sp.	3	2	5
Penicillium sp.	2	4	7
Stachybotrys sp.	0	0	3
Others	7	6	9

(Notes: * produced in the same experimental field as einkorn and emmer)

4. CONCLUSIONS

According to our production experience covering one vegetation period it can be stated that from production technology points of view both einkorn and emmer can be easily integrated into organic farming systems even in areas with poorer production conditions. They have a good adaptability, and we found no plant protection problems related to them. Their sowing time that is known to be optimal coincides with the sowing time of winter wheat, therefore einkorn and emmer should be sown this time if it is possible. According to our experience, late sowing (at the beginning of November) did not cause problems, but in this case the plants were less developed in autumn and in spring, and we found their initial development prolonged.

During the sowing of both wheat species attention should be paid to the fact that the glumaceous seeds can easily get stuck in the sowing duct leading to stoppage and uneven sowing, therefore the sowing duct should be checked several times during sowing, and it need to be cleaned if it is necessary.

In the case of our poor quality experimental field lodging was not observed in the stock having high shoots, which grew after weedy alfalfa preceding crop and manuring.

The tillering of einkorn was much more intensive than the tillering of emmer, and most of its lateral shoots grew heads as well. From the two wheat species einkorn had more favourable general weed and ragweed control features. In spite of its good weed control characteristics, it is advised to perform one weed control operation (with a weed comb) in the tillering phase in the case of emmer, while it is not necessary in the case of einkorn.

The yield level was found to be in strong connection with the length of heads in the case of emmer, while this strong connection was related to productive tillering and the height of the plants having heads in the case of einkorn. The acidic chemical reaction and the low fixity of the soil and the poor availability of phosphorous and nitrogen affected negatively the development and the yield of both wheat species.

By using the same harvester adjustments as during the harvest of rye, but setting a larger vent hole the harvest of the wheat species did not cause any problems. However, a small proportion of the spiculas (about 15%) was thrashed out, and these cases we found some broken seeds as well.

It is advised to pay attention to the risk of potential toxin production during the storage and the processing of the seed grains.

Acknowledgments

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Literature

[1.] Bartl K, Üveges V (2005) Alakor (Triticum monococcum L. ssp. monococcum) gyomelnyomó hatásának vizsgálata szabadföldi és laboratóriumi kísérletekben, különös tekintettel a parlagfűre (Ambrosia artemisiifolia L.). XXVII Országos Tudományos Diákköri Konferencia, Biológiai szekció, 2005 március 21-24, Pécs, (*http://biol-otdk2005.pte.hu/21abs_novelet.html, letöltés ideje: 2011. szeptember 8.*)

[2.] Gyulai F (2002) *Táplálkozás a történeti korokban*. Környezet és Tájgazdálkodási Intézet, Gödöllő

[3.] Gyulai F (2009) A tönkölybúza története. In: *Az ezerarcú tönkölybúza* (Paszternák F) Mezőgazda Kiadó, Budapest, pp. 7-30., 87.

[4.] Hegyesné Vecseri B, Kiss Zs, Kun Sz, Fogarasi A L (2011) Alakor a sörkészítésben. *Biokultúra Magazin*, **3,** (*http://www.biokontroll.hu/cms/index.php?option=com_content&view=article&id=1094%3Aalakor-a-soerkeszitesben&catid=118%3Atudomanyatermelesnek&Itemid=43&lang=hu, letöltés ideje: 2011. szeptember 8.*)

[5.] Koháry E (szerk.) (2003) *Eleven örökség – Kenyér- és kásanövények a Kárpát-medencében*. Agroinform Kiadó, Budapest

[6.] Kovács G (2009a) Új fajok a martonvásári biovetőmag kínálatban. *Martonvásár*, 2, 26.

[7.] Kovács G (2009b) Az alakor ökológiai nemesítése és termesztése. *Biokultúra Magazin*, 5, (*http://www.biokontroll.hu/cms/index.php?option=com_content&view=article&id=563%3Aaz-alakor-oekologiai-nemesitese-es-termesztese&catid=112%3Anovenytermesztes&Itemid=43&lang=hu, letöltés ideje: 2011. szeptember 8.*)

[8.] Kovács G (2010) Az alakor organikus termesztése. *Martonvásár*, 2, 20-21.

[9.] Körber-Grohne U., Küster H. (1989) Archäobotanik-Symposium der Universität Hohenheim (Stuttgart) vom 11.-16. Juli 1988

[10.] Megyeri M, Mikó P, Kovács G (2011) Martonvásári Gabona Génbank: génforrások a kalászos gabonanemesítés számára. *Martonvásár*, 2, 15-17.

[11.] Ortutay Gy (főszerk.) (1982) *Magyar néprajzi lexikon*. Akadémiai Kiadó, Budapest, p. 3570

[12.] Seifert K., Morgan-Jones G., Gams W., Kendrick B. (2011) The Genera of Hypomycetes. CBS Biodiversity Series 9, CBS-KNAW Fungal Biodiversity Centre, Utrecht, Netherlands.

[13.] Sváb J (1981): *Biometriai módszerek a kutatásban*. Mezőgazdasági Kiadó, Budapest, p. 557

[14.] Ujvárosi M. (1973): *Gyomirtás*. Mezőgazdasági Kiadó, Budapest, p. 288