RESEARCHES REGARDING THE OPTIMIZATION OF IMPURITIES REMOVAL TECHNOLOGY FROM THE CEREAL AND INDUSTRIAL PLANT SEEDS FOR ESTABLISHING ECOLOGICAL CROPS
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CERCETĂRI PRIVIND OPTIMIZAREA TEHNOLOGIEI DE ELIMINARE A IMPURITĂȚILOR DIN MASA DE SEMINȚE DE CEREALE ŞI PLANTE TEHNICE DESTINATE ÎNFIINȚĂRII CULTURILOR ECOLOGICE

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ABSTRACT
To ensure maintaining the biological quality of harvested seeds represents a challenge for scientific research in ecological agriculture. The production of seed material, organic certified, depends to a great extent on the functional quality of seed conditioning equipment and installations, but also on the quality of the raw material. Given the importance of knowing the conditioning process of different culture seeds the paper presents a seed conditioning technology and installation that combines two functioning principles: counterflow aspiration and separation on cylindrical sieves. From the results obtained in the experimental research a comparative analysis of the performances of the equipment that could be used by the producers was made.

REZUMAT
Asigurarea menținerii calității biologice a semințelor recoltate, reprezintă o provocare pentru cercetarea științifică în agricultura ecologică. Producția de material semincer certificate ecologic, depinde în mare măsură de calitatea funcțională a echipamentelor și instalațiilor de condiționare a semințelor, dar și de calitatea materiei prime. Având în vedere importanța cunoașterii procesului de condiționare a diferitelor semințe de cultură, lucrarea prezintă o tehnologie și o instalație de condiționare a semințelor, care combină două principii de funcționare: aspirație în contracurent și separarea pe sitele cilindrice. Din rezultatele obtinute în cercetarea experimentală s-a realizat analiza comparativă a performanțelor echipamentului ce poate fi utilizat de producătorii.

INTRODUCTION
After the harvesting process, agricultural products (seeds, fruits, vegetables, etc.) cannot be used directly for various purposes such as: preservation, consumption, industrialization, marketing, sowing, etc., as they also contain impurities (plant remains, seeds, weeds, other bodies, etc.) and damaged products. Prior to receiving a specific destination, it is necessary and obligatory for the harvested products to undergo cleaning and sorting operations. In order to reduce and even eliminate the negative influences of the cereal grain impurities, it is necessary to make a pre-cleaning with different equipment or installations. At the same time, for the use of cereal and industrial plant seeds as sowing material, it is necessary to eliminate foreign bodies, which differ from the seeds of agricultural crops in general, by their physical characteristics, as well as the removal of seeds with low germinating capacity, poorly developed ones and cracks. For this reason, the realization of cleaning and sorting technical equipment is a necessity.

MATERIALS AND METHODS
Within the primary processing operations of agricultural products for obtaining high quality final products are also the cleaning and sorting operations, which involve an adequate technological flow (*Brăcăcescu C., Găgeanu I., Popescu S., Kemal C.S., 2016*).

If currently, in some countries, the focus is on predominantly organic agriculture, it is estimated that in the next few years, the importance of technical equipment for cleaning and sorting cereal and technical plant seeds will obviously increase due to the high degree of crop contamination resulting from the elimination of chemical processes to prevent factors that negatively influence their development (herbicide application, chemicalization, etc.) *(Ciobanu V.G., Vişan A.L., Păun A, Nedelcu A., 2015)*.

The cleaning operation, as the first operation within the technological flow of processing agricultural products requires, first of all, cleaning and sorting equipment having its working process based on the difference between the physical characteristics of seeds and those of foreign bodies.

In order to meet the needs of cereal and technical plant processors and agricultural farmers, INMA Bucharest has developed a technology, (Fig.1) (*Păun A., et al., 2016*) and a pilot installation for seed conditioning ISC (Fig. 2) (*Păun A., et al., 2016*), which is composed of high capacity combined-type technical equipment (pre-cleaning module and cylindrical sieve) (*Păun A., et al.-2016*).

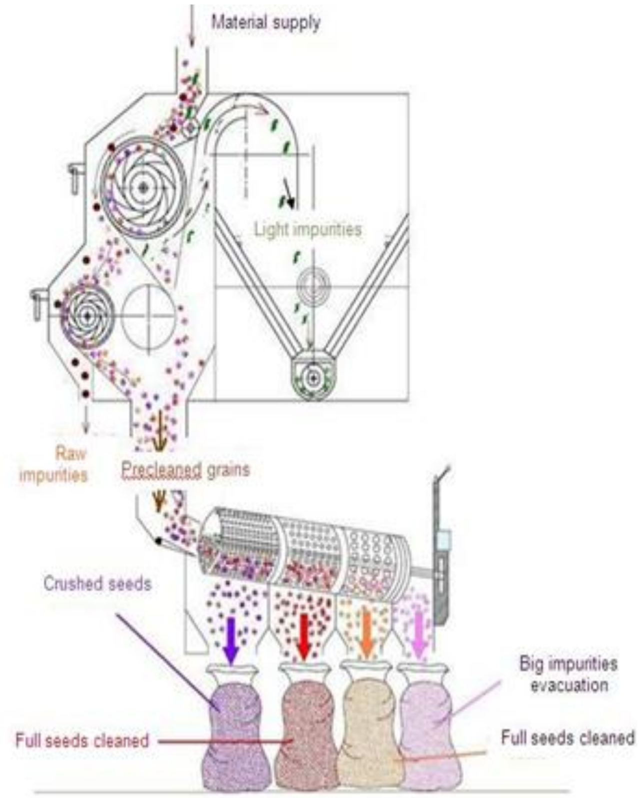

Fig. 1 - Seeds for conditioning technology [9]

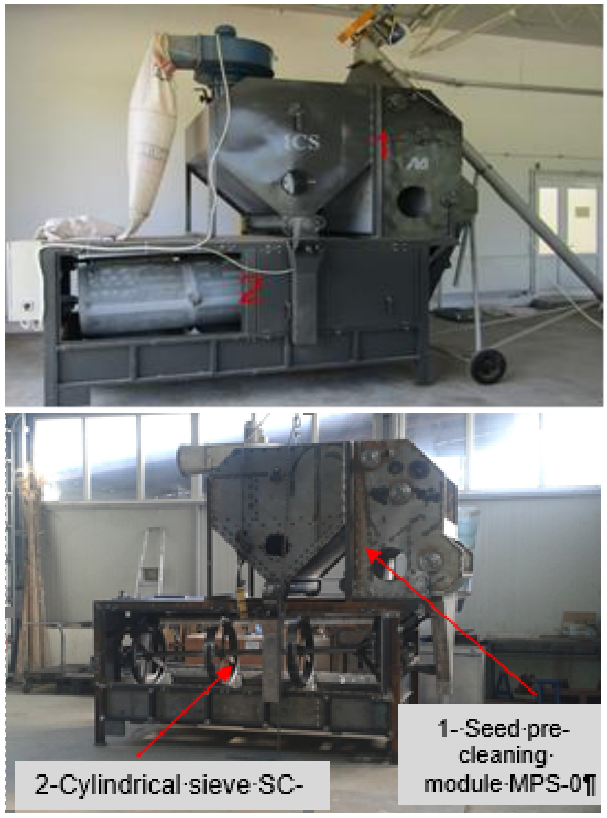

Fig. 2 – ICS seed conditioning installation

The seed conditioning installation is designed to improve harmonised technologies for the production of organic seed in cereals, legumes for grains, oilseeds, industrial and fodder plants, aromatic and medicinal plants, to solve practical problems concerning the production of organic seed for field cultures and planting material, organic certified, at farmers. It has the role of removing from the processed product the impurities that affect its quality.

Aligned to the most modern trends, incorporating the latest design solutions, the ICS installation uses in the seed pre-cleaning process, within the pre-cleaning module, two combined principles: separation on two sieve drums and the counter flow aspiration of the product. The product, pre-cleaned of coarse foreign bodies and light impurities, reaches the cylindrical sieve where separation in several fractions takes place.

The adopted constructive solution allows changing the inclination angle of the cylindrical sieve and also, to increase the productivity and the technological sorting effect, it is provided with inner inclined planes (*Păun A. et al., 2016*).

Main technical and functioning characteristics of the pilot installation ICS are:

- ***Seed pre-cleaning module MPS-0.*** This equipment has a productive capacity of 8 [t/h] for a standard product, respectively a working capacity higher than 5 [kg/hl] for wheat (humidity of 6 ÷ 8 [%]) and a cleaning degree of 40 ÷ 50 [%];

- ***Cylindrical sieve SC-0.*** This equipment presents a selection capacity of 3 ÷ 4 [t/h], a sieve rotation frequency of 14 [min-1] and an installed power 75 [kW].

In order to determine cereal seed pre-cleaning degree, experiments were carried out with the seed conditioning installation, at INMA, under operating conditions, using as raw material seeds of: wheat that was not pre-cleaned, camelina and soy, purchased on the market.

Considering the technological role of the seed conditioning installation, samples were taken and laboratory analyses were performed at: seeds entering the pre-cleaning module; seeds going out from the pre-cleaning module; the outlet of the product decanted in the cyclone; the outlets (sieved products) from the three segments of the cylindrical sieve and the plus material on the last element of the cylindrical sieve.

The technological effect of the installation was analysed against product standards and assessed according to the following results obtained at a single pass through the installation of the product to be processed (*Tarcolea C. et al, 2008, Paun A. et al, 2012*).

During the experimental research activities of the pilot installation, the following determinations were made: large impurities extraction evaluated using the E_{csM} [%] coefficient and defined in eq. (1); small impurities extraction evaluated using the E_{csm} [%] coefficient and defined in eq. (2) and light impurities extraction (weeds, dust particles, bents, vegetal pieces, husks with dimensions smaller than 1.5 [mm]) evaluated using the E_{csu} [%] coefficient and presented in eq. (3).

$$E_{csM} = [(C_{sMi} - C_{sMe}) / C_{sMi}] \times 100 \ [\%] \quad (1)$$

$$E_{csm} = [(C_{smi} - C_{sme}) / C_{smi}] \times 100 \ [\%] \quad (2)$$

$$E_{csu} = [(C_{sui} - C_{sue}) / C_{sui}] \times 100 \ [\%] \quad (3)$$

The terms used in the above equations have the next significations: the C_{sMi} is the content of large impurities at installation inlet, [%]; the C_{sMe} is the large impurities content at the installation outlet, [%]; the C_{smi} is the small impurities content at the installation inlet, [%]; the C_{sme} is the content of small impurities content at the installation outlet, [%]; the C_{sui} is the light impurities content at the installation inlet, [%] and the C_{sue} is the content of light foreign bodies at the installation outlet [%].

RESULTS

The results obtained from experimental research activities carried out under operating conditions of the ICS installation that is equipped with MPS module are presented in Tables 1 and 2.

During the laboratory analyses were obtained the humidity and impurity of the samples extracted from the supply and evacuation seed material and their pictures are presented in Fig. 3, 4 and 5.

Table 1

Experimental results obtained from ICS under operating conditions

Measured parameter	Sample no.	Camelina seeds		Soy seeds		Wheat seeds	
		Product inlet	Product outlet	Product inlet	Product outlet	Product inlet	Product outlet
Humidity [%]	S I	7.6	7.4	7.355	7.35	7.6	7.4
	S II	7.4	7.5	7.358	6.6	7.4	7.3
	S III	7.7	7.5	7.356	6.5	7.7	7.35
	Average value	7.57	7.47	7.36	6.82	7.57	7.35
Seed mass [kg/hl]	S I	61.2	61.2	69.35	69.168	74.3	74.1
	S II	63.3	63.3	69.35	69.05	79.3	79.05
	S III	64.1	64.1	69.35	68.95	79.1	78.95
	Average value	62.87	62.87	69.35	69.06	77.57	77.37
Seed purity [%]	S I	63.01	93.05	90.5	98.54	96.2	98.9
	S II	63.1	93.15	91.3	98.82	94.8	99.1
	S III	63.28	93.1	91.1	97.64	95.1	98.8
	Average value	63.13	93.10	90.97	98.33	95.37	98.93

Table 2

Determinations regarding the quality of processed seeds

Measured parameter	Sample no.	Camelina seeds			Soy seeds			Wheat seeds		
		Product inlet	Product outlet		Product inlet	Product outlet		Product inlet	Product outlet	
Light impurities content collected at fan evacuation [%]		C_{sui}	C_{sue}	E_{csu}	C_{sui}	C_{sue}	E_{csu}	C_{sui}	C_{sue}	E_{csu}
	S I	19.58	3.7	81.10	0.54	0.006	98.89	0.72	0.19	73.61
	S II	19.7	3.68	81.32	0.59	0.005	99.15	0.68	0.2	70.59
	S III	19.68	3.74	81.00	0.47	0.006	98.72	0.65	0.17	73.85
	Average value	19.68	3.71	81.15	0.533	0.006	98.87	0.68	0.19	72.06
Small impurities evacuated by the helical horizontal conveyor [%]		C_{smi}	C_{sme}	E_{csm}	C_{smi}	C_{sme}	E_{csm}	C_{smi}	C_{sme}	E_{csm}
	S I	13.63	2.61	80.85	0.24	0.008	96.67	0.22	0.04	81.82
	S II	13.6	2.64	80.59	0.22	0.007	96.82	0.25	0.04	84.00
	S III	13.65	2.66	80.51	0.25	0.009	96.40	0.23	0.06	73.91
	Average value	13.63	2.63	80.70	0.237	0.008	96.62	0.23	0.047	79.57
Large impurities evacuated by the tram [%]		C_{sMi}	C_{sMe}	E_{csM}	C_{sMi}	C_{sMe}	E_{csM}	C_{sMi}	C_{sMe}	E_{csM}
	S I	3.51	0.54	84.62	1.5	0.3	80.00	1.7	0.2	88.24
	S II	3.59	0.58	83.84	1.55	0.4	74.19	1.9	0.28	85.26
	S III	3.58	0.6	83.24	1.42	0.3	78.87	1.65	0.3	81.82
	Average value	3.56	0.56	84.27	1.49	0.33	77.85	1.75	0.26	85.14
Cracks [%]	S I	-	-		2.10	0.4		1.5	0.2	
	S II	-	-		2.01	0.6		1.7	0.25	
	S III	-	-		1.74	0.9		1.4	0.21	
	Average value	-	-		1.95	0.63		1.53	0.22	


Quality of unprocesed camelina seeds


By product colected after MPS


Camelina seeds sieved by sive no.1


Camelina seeds sieved by seive no.2


Camelina seeds sieved by seive no.3


Material evacuated by sieve no.3

Fig. 3 - Samples collected during the technological flow of ICS when it processed the camelina seeds



Quality of unprocesed soy seeds | By product colected after MPS | Soy seeds sieved by sive no.1



Soy seeds sieved by seive no.2 | Soy seeds sieved by seive no.3 | Material evacuated by sieve no.3

Fig. 4 - Samples collected during the technological flow of ICS when it processed the soy seeds


By product colected after MPS | Wheat sieved by sive no.1



Wheat sieved by seive no.2 | Wheat sieved by seive no.3 | Material evacuated by sieve no.3

Fig. 5 - Samples collected during the tehnological flow of ICS when it procesed the wheat

In fig. 6 is presented the graphical distribution of impurities extraction from seed mass during the ICS technological process for different types of seeds, beginning form the small ones – camelina seeds and ending with soy seeds.

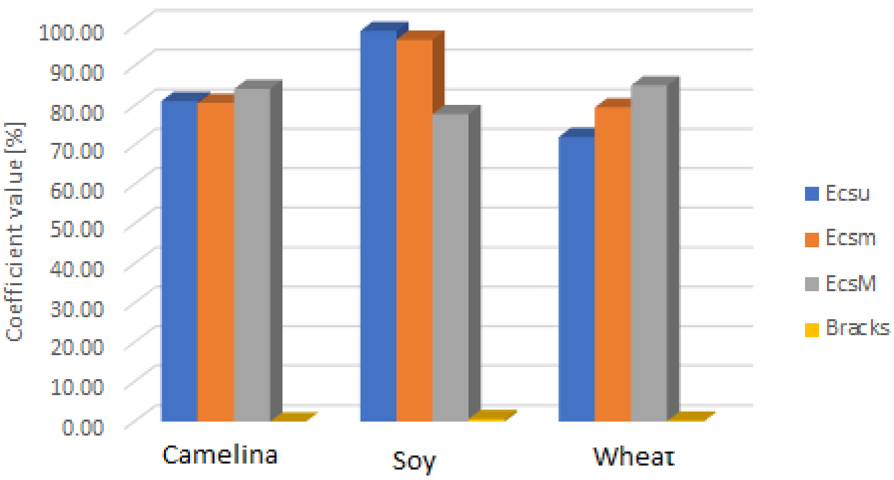

Fig. 6 - The distribution of the impurities extraction from seeds that are processed by ICS installation

Analysing this data can be concluded that the separation process by fractions can be easily made if the seed dimensions are considerably higher, but at the same time the amount of breakage is much higher (see also Table 2) while the cracks evacuation percentage is maintained at the same value.

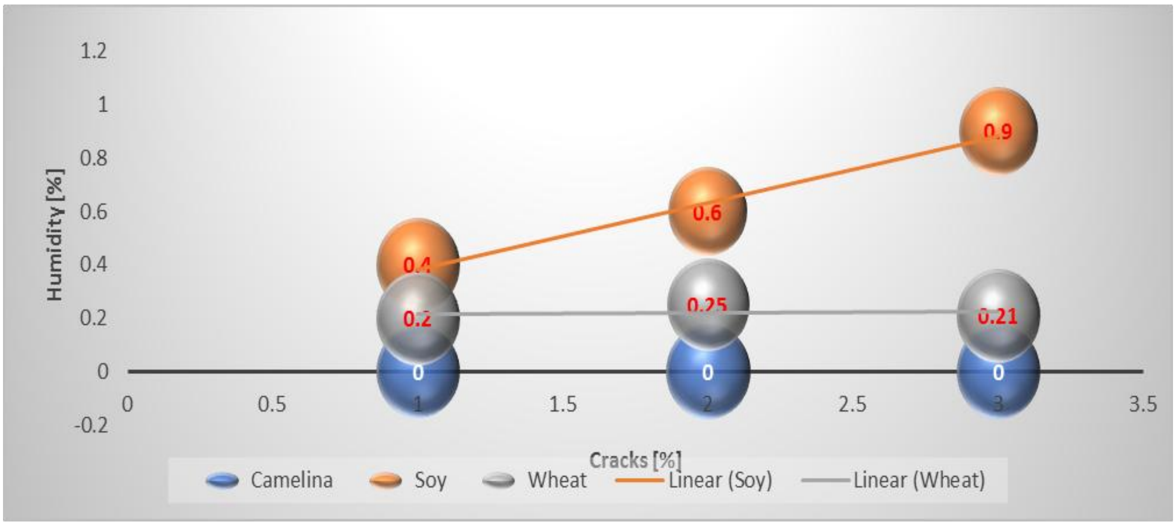

Fig. 7 - The distribution of the cracks from procesed seed mass in acordance with material humidity

If we take a close look at the crack percentage of cracks in the processed seed material it can be seen that it has increased. The most concerning case is that of the soy beans because its tendency increased rapidly by almost 50% from sample to sample, even if the feeding material is maintained constant and the humidity has decreased only by 0.855 [%].

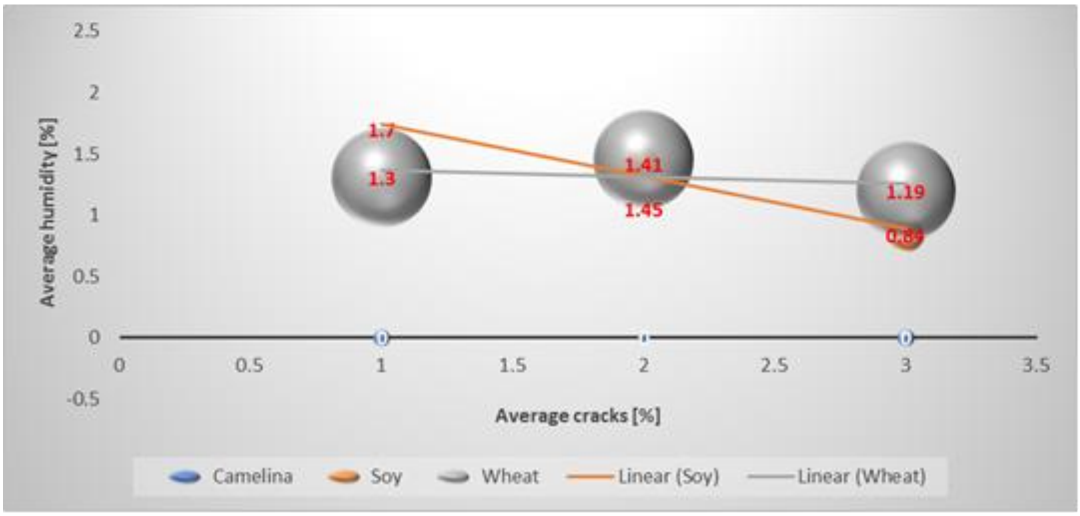

Fig. 8 - The distribution of the cracks from procesed seed mass in acordance with material humidity

In fig. 8 is presented an important aspect of the seed mass processing: if the separation process takes place into the air tunnel, the seeds can modify their humidity and sometimes can increase their fragility; this way, the processed seed mass can increase the cracks percentage, as it can be seen in Table 2.

In fact, the camelina seed mass has no cracks and their humidity can be compared easily with the wheat material, but the dimensions are smaller and also their external surface, fact that has no influence during the seed dynamics and assures its integrity during the technological process.

Comparing wheat humidity with soy seeds, it can be noticed that there is a slight difference, and if it is correlated with dimensional and mass aspects it can be clearly concluded that, from a certain point, the technologic parameter must be controlled in order to decrease the cracks percentage in the processed material. If this aspect is not considered, the technological process cannot be adequately controlled and that leads to the fact that the separation process can be compromised.

CONCLUSIONS

This installation has the ability to remove impurities of unthreshed wheat seeds and due to the pre-cleaning process performed by ICS they are successfully eliminated. This process must be well controlled so that the speed of the air flow above the seed flow limit can aspirate beside the impurities also the good seeds that are then directed to the cyclone and from there to the residues, applying the principle of impurities separation based on the difference in aerodynamic properties between seeds and impurities. The separation module has the ability to adjust the flow rate of the air flow in the suction channels by altering the geometry of the transverse section thereof by actuating some control valves.

To eliminate large impurities like straws, cobs, ears, etc. which can cause installation clogging, which obstruct or stop the grains flowing from the installation, the module with cylindrical sieves is mounted. The pre-cleaning module MPS-0 ensures an optimum drive mode of the seeds and impurities mass using two sieve drums which can be replaced depending on the seeds undergoing pre-cleaning.

The ICS has been designed to ensure high-purity cereal and industrial plant seeds used in organic crops establishment, a need that is increasingly present to farmers who want to set up crops with high nutritional and economic value.

In this paper are underlined some technological aspects that must be considered during the seed separation process in order to lead to a product in line with market product standard. In the next papers will be presented further research results on different seeds with different humidity, and will be presented a dedicated controlling system that will allow adapting the process parameters to seed humidity and dimensions.

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