

## TECHNICAL FESEABILITY FOR ELECTRON BEAM APPLICATION ON MAIZE SEEDS DISINFECTION FOR MAIZE CULTIVATION IN BRAZIL

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### ABSTRACT

Among the man made activities agriculture plays a fundamental rule on the interference with environment; new alternatives for clean technologies are being searched in order to reduce the impact and degradation of the environment. This work presents a feseability study to implement in Brazil a technology using electron beam treatment to disinfect maize seeds avoiding the spoilage from patogens microrganismos. This technology was developed in Germany by Fraunhofer Institut FEP (Dresden) and the private company Schimdt-Seeger AG. It was patented as “e-ventus”. Concerning to the technical feseability it shows to be quite useful due to the results of the experiments performed in other countries with maize seeds and properly for the large amount to be treated in the country. Under the environmental management it is quite advantageous when compared with the tradicional technology that uses chemical seed dressing agents. Nevertheless for a large scale commercial application it is necessary a cost analyse comparison study between the tradicional technology and the alternative using electron beam.

Keywords: seed dressing; *Zea mays*; electron beam; ionizing radiation; stored grains

### 1. INTRODUCTION

This work presents a study of the technical availability on application of the ionizing radiation produced by the electrons beam accelerators (EB) to disinfect maize seeds (*Zea mays*) for cultivation in Brazil and the corresponding benefits for the environmental management, leading to present an alternative for the chemical treatment technology that is nowadays used for seed dressing which can produce negative impacts for the environment.

The infestation of the stored grain as well as other pathogenus such as fungus are the main producers of the grain seed losses during the storage. There are many different species and its incidence can provoke damages such as the grain weight loss; germinating power loss; nutrition value loss; comercial standard reduction; quality loss due to the contamination of the grain mass. Besides these aspects, the insect infestation attacks are considered one of the main causes of the fungus dissemination that are spread by spores, bringing more damage to the grains. The main fungus that are spread and infect the maize seeds are *Fusarium moniliforme* and *Cephalosporium* sp., in seed production fields; and *Aspergillus* spp. and *Penicillium* spp., in storage conditions [1].

## 2. SEED TREATMENT

### 2.1. Conventional Technology

The chemical treatment can be classified in two methods: dry and wet. In the first case, the insecticide/fungicide is mixed with seeds inside a device similar to a concrete mixer with two degrees of rotating movement, to get a better mixture. In the second method, chemical solutions are applied by pulverization or immersion. The most used products for the seed dressing (expressed in a.i.- active ingredient) are: a) insecticides- deltamethrin, carbosulfane, carbofuran, thiodicarb, imidacloprid, thiametoxan, aluminum phosphate, methyl bromide, bifenthrin, pirimiphos-methyl, and b) fungicides- captan, thiram, thiabendazole, tolfenfluanid, carboxin, fludioxonil. The fumigation is another seed dressing methodology. The lots are exposed to methyl bromide in closed recipients during a setup time. However this method does not eliminate the pathogens inside the seed and does not avoid infestation of microorganism presented in the soil.

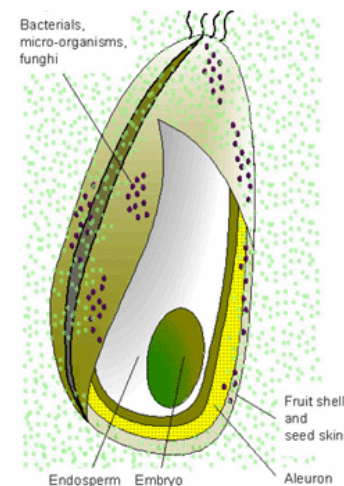
### 2.2. The Proposed Alternative Technology

According to the tendency of searching for cleaner alternative methodologies, the seed treatment technology using ionizing radiation produced by electron accelerators (electron beam- EB) presents as an environmentally friendly alternative without the use of chemicals.

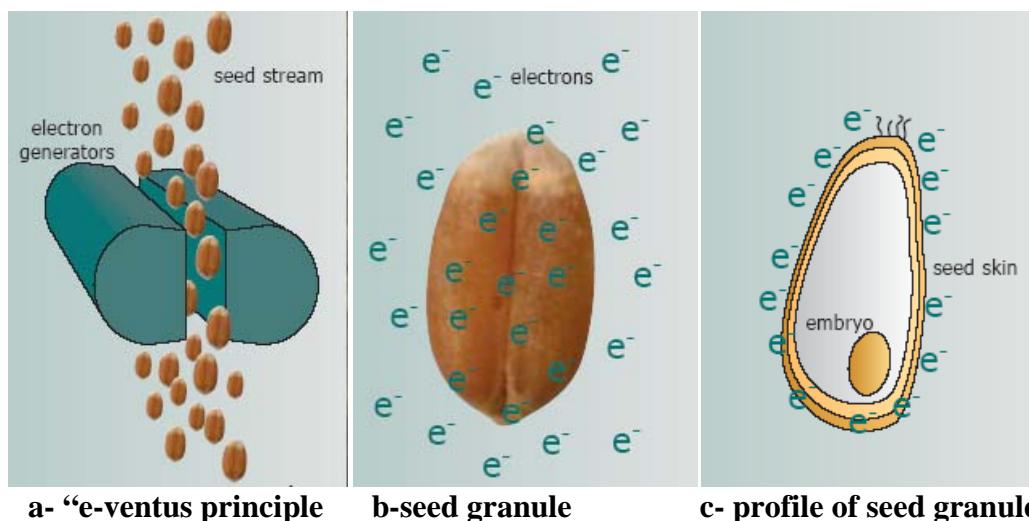
#### 2.2.1. Electron Beam Seed Treatment

The penetration power of the electron beam depends on the intensity of the electrical field in which it is accelerated. Due to this characteristic, German researches have built accelerators that permit by controlling the accelerating field the adjustment of the electrons penetration power to not overpass the seed shell that normally ranges from 0,025mm to 0,5mm. The interaction of the radiation with the product is adjusted to occur only in the seed shell where the undesirable microorganisms are present (Fig. 1), preserving the inner part and the embryonic properties.

If the inner part of seed absorbs the energy of the EB the embryonic cells will be damaged, provoking the lethality or mutagenicity with reduction of the germinative properties. Figure 2 shows the controlled energy EB operation principle for grain disinfections.



**FIGURE 1 – Scheme of the infected seed by microorganisms [6]**



**FIGURE 2 – Controlled Energy EB operation principle[6]**

This technique was widely tested with wheat and barley seeds [2] and it was successfully tested with maize seeds[7], that is the subject of this study.

### **3. AVAILABILITY STUDY**

According to the foresights in 2015 the necessary Brazilian maize harvest to attend the animal food segment should be 55 million tons, requiring close to 472 thousands of seed maize. Considering national average productivity of 3.5tons/hectare (using 30kg of seed to plant 1 hectare), if the actual 13 million hectares of area set apart to the production of maize are kept, in order to reach the 55 million tons of grain it will be necessary to increase the national average production to at least 4,2 ton/ha. That means the necessity to introduce new planting technology to increase the efficiency.

#### **3.1. The Technical Availability for the Use of Seed Treatment with Electron Beam**

In the last decade experiments using EB for seed treatment was carried out efficiently in Germany to control a series of diseases in seeds. The association between the Fraunhofer Institut- FEP – Dresden, Germany and the company Schimdt Seeger AG developed and built a movable demonstration facility using the purely physical nature based on effect of low energy electron beam to bombard the seeds, where the seeds are in a continuous flow drop off by gravity, are submitted to the bombardment of two electron beam emitted by two contraposed accelerators, with the energy ranging from 105 to 145 KeV, permitting a uniformity interaction inside the thickness of seed shell.

Figure 2 shows the irradiation system which was patented [5] and commercially named “ e-ventus”. The main characteristic of this facility is the assembling on a truck bed which allows to move where the treatment is necessary and easily be plugged in the seed storage silos. This characteristic is of great importance considering the logistic aspect, reducing the transportation cost and the problems associated with mechanical damages to the products and

the possibility of the seed recontamination. The seed treatment capacity of “e-ventus” is around 30 ton/hour.

The “e-ventus” process was used in experiments made by the University of Agricultural Science and Veterinary Medicine of the Banat in Timisoara – Romania, where the seed irradiation technology of the hybrid maize with low energy electron beam was compared with the traditional method of seed dressing using chemicals. The results of these experiments compared with non treated seeds were that the chemical dressing showed an increasing of 5% in the production, while the seed treatment using low energy electron beam the increasing was 11% [7].

The variable cost (energy and maintenance) of the lab operation is approximately 3,5 Euros per ton [6]. This value indicates that the major part in the composition of the final cost of the treatment process is due to the fixed costs where the capital cost and amortization of the capital are the most representative values. The cost of the demonstration lab is approximately 1,500,000 Euros. Nowadays the national average production is 44 million tons of maize, considering the actual conditions which warrant the productivity of 3,5 tons/hectare using 30kg of seed per hectare, it is necessary to use 377 thousand tons of seeds. In order to process this quantity it would be necessary at least two units, operating continuously 24 hours a day, to make this business available considering the economical aspects.

It is important to point out that the use of EB for seed treatment does not leave hazardous waste, allowing without hesitation to be combined with other planting technologies, for example, the inoculation technique to improve the nutrition fixation or adding agents that promote the antagonism to the harmful microorganisms which attack the seeds on the soil [5]. Besides the quality assurance of the seeds used for planting, this technology equally favors the part of the grains directed to be used by the industry, mainly for animal food, as well as to the exportation sector which needs long periods of storage, becoming sensitive to the insect attacks and other pathogenic organisms.

According to the safety of the process, it was mentioned in the introduction of this paper that the energy levels used to accelerate the electrons and the interaction occurred in the seed belong to a physical-chemical nature which extinguish the existing microorganisms in the seed shell without change of the vitality of the seed and the most important is that the processed product do not become radioactive.

### **3.2. Environmental Impact**

The annual consumption of agriculture chemicals (toxic compounds) in Brazil has been over 300 thousand tons. When expressed by quantity of active ingredients (a.i.), the value is about 130 thousand tons. Besides the risks to human being on food and public health aspects, it is known that the introduction of this chemicals in the environment induce undesirable effects, changing the ecological system [8], mainly by the soil and water resources contamination originated from the throw the agricultural activities waste that are carried by the irrigation, rain (erosion and lixiviation)

The product Metil Bromide, widely used in the fumigation technique for stored grain plagues, has been forbidden in Brasil since January 1<sup>st</sup>, 2007 by the Ministério do Meio Ambiente e Ministério da Saúde (Environmental and Health Ministeries). According to Montreal Protocol, the Metil Bromide was included in the list of substances that destroy the ozone

atmosphere layer and its use will be forbidden after 2015 in the developing countries [9]. The seeds treated by chemicals may present a reduction in the availability and in the vigor when stored for a long period [10], under the disposal necessity of these seeds, there is a potential risk to the soil and ground water contamination by the products used in the treatment. According to the environmental point of view, the seed irradiation treatment using EB technology implies in positive impacts because of the numerous advantages when compared with the chemical technology treatment. The following aspects can be stated:

- It is a physical process without use of chemicals ;
- It does not use dangerous substances normally used with other processes;
- It does not contaminate the soil and water resources ; it does not produce hazardous waste;
- In case of excess production of seed, it can be used to feed animals , once it is not a hazardous waste;
- No ingestion of chemical plant agents by animals with the seeds;
- It presents an excellent phytosanitary effect which will provide good production yield;
- The pathogens do not develop resistance as it can occur when chemical products are used, interfering in the local biodiversity;
- It does not affect Natural Enemies (pathogens and plagues biological control agents) that are agricultural-friendly insects and microorganisms which are incident during the beginning of planting process.

More environmental advantages can be added to these such as : possibility of treating great quantity of seeds (about 30tons/hour). This technology uses ionizing radiation requiring a rigorous processing license by the Nuclear Energy National Commission (CNEN) that increases the safety of the process.

#### **4. CONCLUSIONS**

The positive results of the experiments using the irradiation technology of maize seeds and others with the purpose of eliminating the pathogens contamination can be considered technically available to be applied in Brazil, mainly when the number of the local production is meaningful with this kind of grain. If it was taking in account only the increase of the productivity performed in Timisoara – Romenia, using the “e-ventus” technology it means actually a local production increment of more than 2 millions tons of maize. The commercial value of this increment represents more than U\$200 million American dollars, that is enough to invest in one year only in the acquisition of the necessary number of facilities to process the seeds used on Brazilian maize production. Of course this friendly values must be verified under the efficiency on using this technology with local maize seeds planting technology and related logistic.

In the environmental managing sector this technology presents meaningful advantages when compared with the usual technology in the country which still uses chemical products for seeds disinfection. It will become up as an available technology when the limits imposed by environmental regulations (2015) for the use of hazardous chemicals products in agriculture will take effect.

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