INFLUENCE OF ELECTRIC FIELD ON THE QUALITY OF FLAXSEED

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Abstract

The following steps are used in the processing of the seeds in order to improve their quality before planting--cleaning, separation, treating with fungicide and stimulation of germination. This paper describes the effect of an electric field in these stages of the seed processing technology.

The paper presents a mathematical description of deflection angle; the results of special seed cleaning and grading according to mass; the influence of electric field on the germination of the seeds. The possibility to use the ecologically clean method of the seed processing by an electric field instead of treating with fungicide is discussed.

Keywords: flaxseed, electric field, cleaning, grading, germination, disease.

Introduction

Purity, germination and disease incidences determine seed quality. Seed cleaning and grading (Revenko and Balujeva, 1998, Lvashkov and Tlichev, 1997) can achieve purity and separate small seeds.

The seed cleaning machines used at present separate seeds according to their mechanical properties but cannot remove weed seeds with the similar parameters. We must use the whole complex of the electrical and mechanical characteristics of the seeds in order to separate effectively undesirable seeds. Electric separators could be used at the finishing stage of the cleaning (Kazimirchuk and Xairetdinov, 1995, Pozeliene and Lynikiene, 1998). The electrical properties of the seeds should be regarded while separating according to the mass and germination, because these characteristics are closely connected with their physiological maturity (Podobedov and Tarushkin, 1998).

Germination is one of the major seed quality indicators. Seed grading into individual fractions according to mechanical properties using conventional cleaning machines does not have any effect on germination improvement (Konchenko and Trofimov, 2000). Having conducted an review of scientific-technical and patent literature of the last 10 years it was determined that the most effective work was done when seed germination is stimulated by electromagnetic fields (Davies, 1996, Pietruszewski, 1996, Staselis and Optazas, 1996).

More than 60 % of all the pathogen's of agricultural crops spread with the seeds. For this reason they are treated with fungicides before sowing. This operation is expensive and it has negative influence to the environment and the service personnel. The papers (Objedkov, 1998, Shmigel and Nijazov, 1998) describing the ecologically clean method removal pathogenic bacterium from seeds surface in the electric field.

Theory and Procedure

The conveyor type electric separator (Fig.1) processes the seed. The seeds get the charge from the potential electrode in the horizontal part of grounded belt. The seeds separate from the belt in its cylindrical part and enter in to the pans of the classifier, according to their mass and charge. If one assumes that the seeds are at rest with respect to the transport belt, then the angle of deflection in the cylindrical part will be:

$$\alpha = \varphi + arcsin\left(\left(\left(F_k + F_v\right) / F_p - K_\omega\right) sin\varphi\right).$$

Where: φ - the friction angle of the seeds, grad; F_k, F_v – electric field and mirror reflection forces, N, $F_k=QE$, $F_v=Q^2/(\pi\varepsilon_o b^2)$; Q – charge of seed, C; E – strength of electric field, V/m; ε_o – electric constant, F/m; F_p, F_{in}, F_{tr} – gravitation, centrifugal and friction forces, N, $F_p=mg$, $F_{in}=mR\omega^2$, $F_{tr}=N\,tg\varphi$; m – mass of seed, kg; R – radius of cylinder, m; ω - angular velocity of cylinder, rad/s; N – surface reaction, N; K_ω - kinematic parameter, $K=R\omega^2/g$.

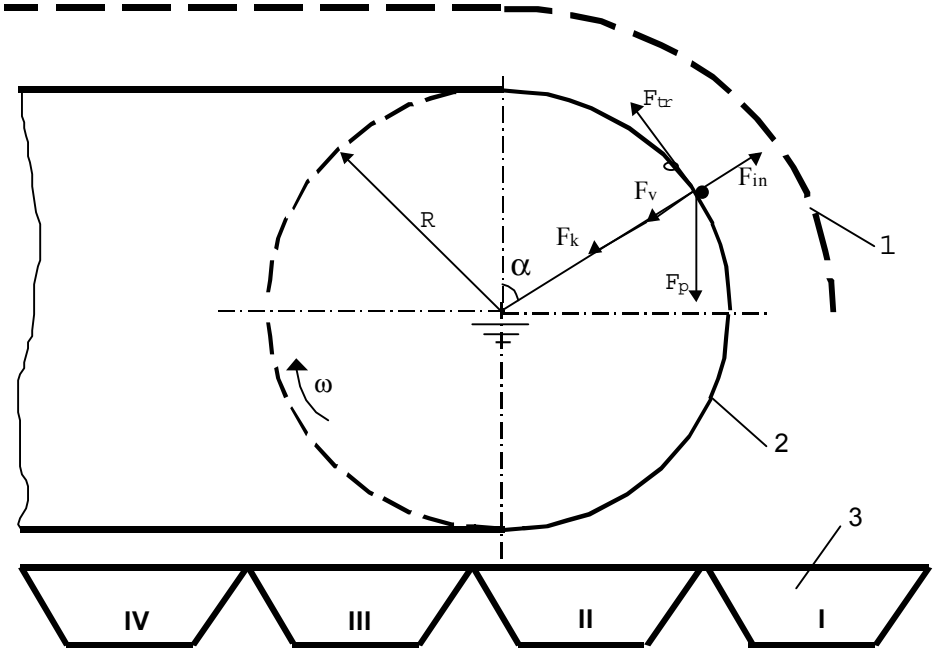

Figure 1. The scheme of transporter type electric separator: 1-potencial electrode; 2- grounded electrode; 3-classifier pans

Seed cleaning and grading tests involving an electrical separator were carried out with the bad quality seeds. Mechanical machines had already cleaned these seeds.
The output, germination, the mass of 1000 seeds and the number of weed seeds were determined in each fraction.

For the evaluation of the effect of an electrical field on the stimulation of seed germination field strength is changed $0.5\cdot10^5$ V/m increments within the range of $(0\text{-}5)\cdot10^5$ V/m. Seed germination for each value of field strength was determined after one week.

The object of investigation is to determine the impact of electric field to flaxseed (linum usitatissimum) cleaning and diseasing. The influence of electric field to the seeds diseases was investigated with three different variables: the untreated seeds; the seeds treated with

fungicide; the seed, processed by the electric field of $4.0 \cdot 10^5$ V/m strength for 2 seconds. The diseases of seeds and plants in various stages of their development were determined during the investigation.

Results and discussion

The results of the seed cleaning and grading tests are given in Table 1.

Table 1. The results of special cleaning and grading of the seeds

Index	Control	Fractions of electric separator				Operation regime	
		I	II	III	IV	E, 10^5 V/m	ω, rad/s
Output, kg	1470	240	630	463	135	4	6.7
Number of weeds (cuscuta epilinum), units/kg	100	0	0	200	400		
Mass of 1000 seeds, g	4.95	5.07	4.98	4.88	4.83		
Germination, %	95	98	98	96	91		
Output, kg	530	100	276	117	37	3	6.7
Number of weeds (lolium remotum), units/kg	600	0	100	300	1200		
Mass of 1000 seeds, g	4.47	4.51	4.49	4.45	4.23		
Germination, %	88	96	94	94	80		
Output, kg	800	80	464	200	56	3	1.7
Number of weeds (various), %	4	0,5	1	6	32		
Mass of 1000 seeds, g	4.26	4.33	4.29	4.21	4.07		
Germination, %	72	88	87	80	78		

Analysis of the results shows that when an electric field is used for cleaning flaxseeds from cuscuta epilinum and lilium remotum 60% of seeds correspond to the requirements for the cleanliness.

When the ordinary weeds are cleaned from the flaxseeds, about 70% seeds have the quality higher than in the control.

The results of the grading show that it is possible to separate 60-70% of the seeds, the mass of which and the germination is greater than the control ones. The check of the difference of the germination of seeds according to t-criteria enable to determine the essential increase of the germination. The average increase of the germination due to the stimulating effect of the electric field is from 2 to 13%.

The influence of electric field strength to the seed germination is shown in Fig.2.

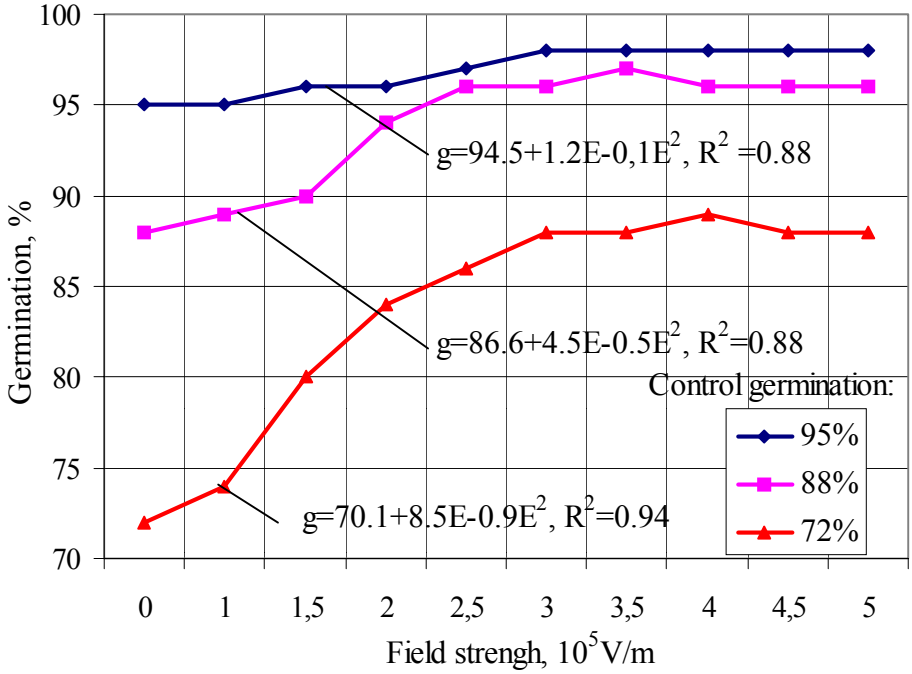

Figure 2. The relationship between the seeds germination and the strength of electric field

The results show that 3-3.5·10^5 V/m field strength is sufficient for stimulating seed germination. Further increasing field strength does not increase germination. A parabola describes the relationship between seed germination *g* and field strength *E*.
Fig. 3 the indices of the average diseases in various stages of the development of the plant are given as the result of the three-year investigations.

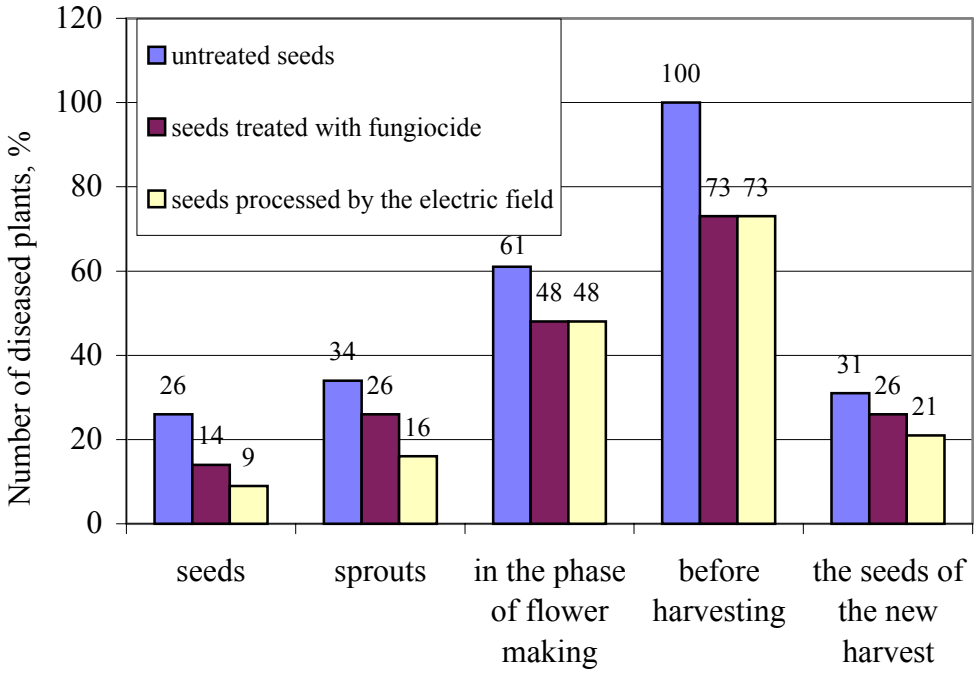

Figure 3. The number of the diseased plants in different stages of their development

The results show that the diseases of the seeds processed by the electric field, the sprouts of such seeds and the seeds of the new yield was less than the diseases of the seeds treated with fungicide and the sprouts of such seeds. In the following stages of the plant development the diseases of the seeds treated with fungicide and those processed by the electric field is the same. The statistical processing of the data of the investigation enable to conclude that at the confidence of 0.95, the impact of the electric field has the essential influence to the minimization of the seed diseases.

Conclusion

1. The seed grading in the electric field enables to separate 60-70% of the biologically valuable seeds, the mass of which and the germination exceeds the control indicators.
2. The impact of the electric field stimulates the germination of the seed. The maximum addition of germination was given by the strength of field 3-3.5 kV/cm.
3. The influence of the electric field is essential for the minimization of the diseases of the seed.

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