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ALFALFA SEED CLEANING USING A MAGNETIC SEPARATOR

PREČIŠĆAVANJE SEMENA LUCERKE NA MAGNETNOM PREČISTAČU

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ABSTRACT

The paper analyzes alfalfa seed cleaning using a magnetic separator, and the influence of the dodder seed amount on the cleaned seed amount. Seed cleaning was performed at the Institute of Field and Vegetable Crops in Novi Sad and three alfalfa seed lots were cleaned after passing through the primary cleaning process (selector, gravity table and roll mill). After cleaning, the quantity of pure seed (kg), waste (kg) and the time used for cleaning (h) was measured. The input quantity of all three seed lots was 1000 kg, whereas the waste ranged from 7.8 to 9.8 kg after cleaning. The purpose of this study is to monitor the operation of a magnetic separator in order to determine the amount of waste after cleaning. On the basis of the results obtained, an insight into the influence of the dodder seed amount on the cleaning rate and the required number of cleaning repetitions was obtained.

***Key words**: alfalfa seed, dodder seed, magnetic separator, seed cleaning*

REZIME

Pri doradi semena lucerke veoma je važno dobiti čisto seme bez prisutva karantinskih korova. U radu je analiziran proces dorade semena lucerke na magnetnom prečistaču (dekuskutoru) tipa Emceka Gompper i uticaj količine semena viline kosice (Cuscuta spp.) *na dobijenu količinu prečišćenog semena. Po zakonu o čistoći semena, u dorađenom semenu lucerke nije dozvoljeno prisustvo ni jednog semena viline kosice. Dorada semena lucerke urađena je u Zavodu za krmno bilje u Institutu za ratarstvo i povrtarstvo u Novom Sadu, a dorađivane su tri partije semena koje je prošlo primarni proces dorade (selektor, gravitacioni sto i rol mašinu). Partije su imale različitu količinu semena viline kosice. Nakon procesa dorade je merena količina čistog semena (kg), otpada (kg) i vremena potrebnog za prečišćavanje (h). Ulazna količina sve tri prečišćavanje partije semena lucerke je iznosila 1000 kg a nakon prečišćavanja otpad je iznosio od 7,8 do 9,8 kg. Cilj ispitivanja je bio praćenje rada mašine Emceka Gompper kako bi se ustanovila količina izdvojenog otpada, tj gubitaka semena u procesu prečišćavanja. Na osnovu rezultata dobija se uvid u uticaj količine semena viline kosice na brzinu prečišćavanja i potreban broj ponavljanja prečišćavanja semena lucerke.*

***Ključne reči**: dorada, vilina kosica, magnetni dekuskutor, seme lucerke*

INTRODUCTION

Alfalfa *(Medicago sativa)* is the most important perennial forage legume due to the yield and feed quality, as well as the area devoted to it both in our country and the world *(Karagić et al., 2011).* Provided nutritional value is observed, alfalfa belongs to one of the leading fodder plants in the bulky fodder production. Alfalfa seed represents a very competitive product in the market (Figure 1). The physical and biological characteristics of alfalfa seed contribute to its easy transport from region to region. If properly stored, alfalfa seed retains germination for several years. Due to a low moisture content (up to 9 %), alfalfa seed is susceptible to a relatively small number of pests when stocked. These properties make alfalfa seed very suitable for both domestic and international trade *(Karagić et al., 2011).*

Fig. 1: Packaged alfalfa seed

The quality of alfalfa seed is determined by a number of parameters (namely germination, purity, moisture, etc.) which depend on several production factors (namely weather conditions of ripening, culture practices, etc) as well as handling the seed after harvest (cleaning and storage). After harvest, alfalfa seed has a purity of about 80 % so it has to be refined, i.e. cleaned. The seed passes through a series of machines that separate impurities such as dry stems, weeds and broken seeds. Alfalfa seed should possess a purity of at least 95 %, up to 2 % of seeds of other types, 0.5 % of weeds (without quarantine weeds), 2.5 % of inert matter, germination of 70 % and 90 % moisture (Službeni Glasnik SFRJ, 47/1987). The color of the seed dictates the quality and therefore the price, so it is better when the seed has a brighter color (Figure 2).

Fig. 2: Cleaned alfalfa seed

Dodder *(Cuscuta spp.)* is a one-year herbaceous plant from the *Convolvulaceae* family. It belongs to the parasitic plants

because it does not have roots or leaves, and does not carry out photosynthesis. Conversely, it sucks nutrients from the host plant. It is the most frequent parasite of clover, alfalfa, juicy vegetables and cereals, although it can also be found on shrubs and some fruits. Dodder fruits are capsules that contain light brown seeds, and one plant can produce up to 3,000 seeds a year. The big problem is the fact that dodder seeds are able to maintaing germination up to 12 years (Figure 3). The seeds are similar in shape and size to alfalfa seed and it is hard to isolate them during the primary cleaning using a sieve.

Fig. 3: Dodder infested alfalfa

For the establishment and use of alfalfa crops, the seed must be of high purity, germination and genetic value. Most of these requirements are achieved through cleaning, i.e. removing foreign ingredients and low quality seeds. In the process of cleaning fine-grained leguminous seeds, the quantity of the seed depends directly on the percentage of weed species and other substances in the natural seed. If the appropriate cleaning equipment and technology are not used, the result may be an increase in the consumption of processing time and energy leading to seed losses *(Đokić et al., 2009; Đokić et al., 2010; Đokić et al., 2012)*. Seed cleaning is based on the physical characteristics of the seed. Before each treatment, it is necessary to carefully analyze each seed lot in order to obtain the optimal results using the appropriate combination and adjustment of cleaning machines *(Smith 1988; Copeland and McDonald, 2004; Babić and Babić, 1998, Đokić et al., 2012)*. Cleaning results should meet the legally defined seed quality criteria. The conditions and method of production and distribution of seeds are determined by the Law on Seeds and Planting Material (*Glasnik Republike Srbije, 2005)* in accordance with the manual of the International Seed Testing Association *(ISTA, 1999)*. The ultimate objective of seed cleaning is to obtain the highest percentage of pure seed with maximum genetic potential, which reflects on the percentage of seed life (*Copeland O. Lawrence, McDonald Miller 2004).*

MATERIAL AND METHOD

The alfalfa seed cleaning was done at the Institute for Forage Crops of the Institute of Field and Vegetable Crops in Novi Sad. The alfalfa seed samples passed through several machines (a screen selector, a roller machine and a magnetic separator). In this study, the operation of the magnetic separator Emceka-Gompper type 4 was monitored, a seed cleaning machine for eliminating dodder seeds. A magnetic separator is a machine that separates seeds using magnetized rollers. Seeds, which are previously cleaned from other particles except dodder seed, are blended with iron powder before being fed to the machine, to allow separation. Healthy alfalfa seed has a smooth surface, and after mixing, the powder does not retain on its surface. Unlike alfalfa seed, dodder seed is porous and the powder is retained on it, which allows its separation from the alfalfa seed (Figure 4).

The machine was monitored during the cleaning process of three seed lots of different input purity. For each repetition, the following parameters were measured: pure seed (kg), dodder seed (pcs), time needed (h) and seed losses after cleaning (kg). Before the cleaning process, a manual laboratory analysis of seed samples of 50 g was performed. After each repetition of the seed cleaning using a magnetic separator, a manual laboratory analysis of the seed was performed using the MCC Lilliput laboratory magnetic separator (Figure 5). The laboratory magnetic separator purifies a working sample of 1 kg of seeds, after which the presence of the quantity of dodder seed is manually determined from the waste.

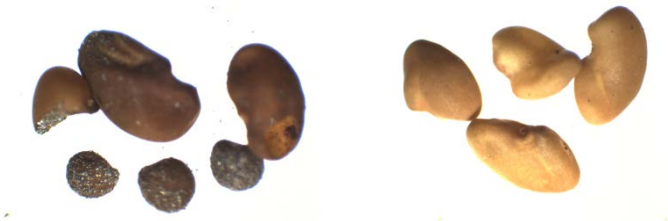

Fig. 4: Poor alfalfa seed and dodder seed with iron powder (left), healthy alfalfa seed (right)

Fig. 5: Laboratory magnetic separator MCC Lilliput

RESULTS AND DISCUSSION

The Emceka-Gompper magnetic separator (Figure 6) is part of a magnetic plant consisting of a magnetic machine, seed mixer, dashboard and elevator. The components of the magnetic machine are a pouring basket and two magnetized rollers. The rollers are powered by an electric motor of 1.5 kW and 1430 rpm. The magnetic machine separates seeds and ingredients according to the surface properties, which means separating the seed with a smooth surface from the rough and damaged seed. The previously cleaned seed passes to the dosing container of the mixer in exactly dosed amounts of 120 kg. The seeds are moistened - either with special oil or water - and mixed with fine iron powder. Iron dust fits into all depressions and rough surfaces *(Emceka - Gompper, GmbH & Co, Installation and Operating Instructions)*. After the mixing process, the seed in the thin layer passes over magnetic rollers attracted by a strong magnetic field. All the ingredients loaded with iron dust are being separated as waste. The input quantity of cleaned alfalfa seed lots was 1000 kg. Before the cleaning using a magnetic separator, seed samples of 50 g were taken to determine the amount of dodder seed. A rough manual analysis of the seed was performed. The quantities determined are given in Table 1:

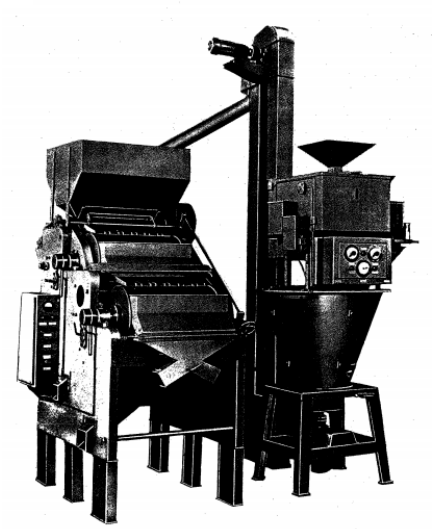

Figure 6: Emceka – Gompper magnetic cleaning machine

Table 1: The number of dodder seed found

Seed found in 50 gr			
Sample	Lot 1	Lot 2	Lot 3
1	1	7	2
2	1	2	1
3	1	5	2
Avg.	**1**	**4,7**	**1,7**

The quantity of water and iron powder is added according to the amount of the dodder seed found.Powder and water are blended with the seeds with an electric motor that drives the mixing spiral. The water flow is regulated using a valve, whereas the set quantity of powder is regulated using a scale and a micro switch. The mixer capacity is 120 kg. After mixing, the seed is inserted into the separator using a seed elevator.

The cleaning speed depends on the thickness of the seed layer that passes onto the rollers. Roller rotations are constant (38 rpm) and the thickness of the layer is regulated by a bolt. The thickness of the seed layer is about 5 mm. If the seed is dirty, the layer must be thinner for more efficient cleaning.

In order to determine the condition after each cleaning repetition using the magnetic separator, a working sample (1 to 1.5 kg) is taken from the cleaned seed amount, which is re-purified using a laboratory separator, and then the manual analysis (from the waste) determines the number of dodder seeds. A laboratory separator does not always separate the same amount of seeds, which depends on the purity. After the first repetition of each lot, it can be concluded that the amount of dodder seed is reduced (Table 2), requiring another cleaning repetition.

Table 2: Dodder seed number after first cleaning:

Dodder pcs found			
Sample	Lot 1	Lot 2	Lot 3
1	1 pc in 20 g	1 pc in 22 g	0 pcs in 20 g
2	1 pc in 23 g	2 pcs in 20 g	0 pcs in 25 g
3	0 pcs in 20 g	1 pc in 17 g	1 pc in 20 g
Avg	**1**	**1,3**	**1**

After the second repetition of alfalfa seed cleaning, no dodder seeds were found in the first and the third lot during the re-sampling and analysis, wheras one dodder seed was found in the second lot, which was the reason for the third repetition of the cleaning process.

The quantities of water and iron powder added during the cleaning of all three lots of the alfalfa seed samples are given in Table 3:

Table 3: The amount of water and iron powder:

Lot 1	Repetition	Water (l)	Powder(g)
	1	0.8	400
	2	0.8	400
Lot 2	Repetition	Water (l)	Powder(g)
	1	1	600
	2	0.8	400
	3	0.8	400
Lot 3	Repetition	Water (l)	Powder (g)
	1	0.8	400
	2	0.8	400

The seed cleaning rate for all three lots is given in Table 4:

Table 4: Cleaning speed:

Lot 1	Repetition	Kg/h
	1	250
	2	250
Lot 2	Repetition	Kg/h
	1	300
	2	300
	3	250
Lot 3	Repetition	Kg/h
	1	250
	2	250

A magnetic separator excludes a certain amount of waste, in which alfalfa seeds are found in addition to dodder seeds. All three seed lots possessed high-quality seeds with small amounts of bad and broken seeds, which were magnetically separated. Table 5 shows seed losses, i.e. poor seed after each treatment.

Table 5: Magnetic separator waste:

Waste [kg]			
Repetition	Lot 1	Lot 2	Lot 3
1	7	7.3	6.8
2	1.5	2	1
3	0	0.5	0
Sum	**8.5**	**9.8**	**7.8**

CONCLUSION

In the cleaning of alfalfa seed using a magnetic separator, the ratio of the input and output quantity of the seed obtained is in direct dependence on the presence of the dodder seed in the alfalfa seed, as well as the quality of the natural alfalfa seed (physical damage during harvest and poor seed). In order to ensure that the separation of dodder seeds is successful with as little loss as possible, it is necessary to adhere to the appropriate cleaning techniques, which requires expert staff and quality cleaning and processing machines. Any defects in the process of cleaning can lead to large seed losses. To reduce the proportion of dodder seed in alfalfa, it is necessary to sow declared processed seeds, and pay attention to the care and protection of crops for obtaining seeds of highest possible purity.

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