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IMPURITIES IN ALFALFA SEED AND THEIR IMPACT ON PROCESSING TECHNOLOGY
PRIMESE U NATURALNOM SEMENU LUCERKE I NJIHOV UTICAJ NA TEHNOLOGIJU DORADE

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ABSTRACT

The aim of this research was to determine relevant parameters and optimal alfalfa seed processing technology by a comparative analysis of two systems of machinery for processing natural alfalfa seed of different purity (59.0% and 71.0%) and with different content of impurities. The relevant parameters monitored during the test were: pure seed (%), weed seeds and seeds of other crops (%), inert matter (%), amount of processed seed (kg), seed processing time (min), consumption of steel powder (kg), water (l), glycerin (ml), and processing yield (%). Alfalfa is the most important forage legume due to its forage quality and growing regions in our country and worldwide. The losses of alfalfa seed in processing are directly dependent on the type and quantity of weeds and other impurities present in the natural seed. In particular, a large amount of impurities and weeds in natural alfalfa seed may be due to the poor condition of crops, as well as improper adjustment of combine harvesters during the harvest. The processing of alfalfa seed is performed by multiple pieces of equipment and devices, including a number of different procedures depending on the initial seed purity. The type of processing machinery and the selection of appropriate technological measures depend on the initial seed purity. The proper setting of processing machinery is also very important in order to obtain optimal results and reduce seed losses during processing.

Key words: *alfalfa, seed, processing technology.*

REZIME

Cilj istraživanja u ovom radu je bio da se uporednim ispitivanjem dva sistema mašina za doradu semena lucerke pri doradi naturalnog semena dve različite čistoće (59,0% i 71,0%), s različitim sadržajem primesa odrede relevantni parametri, odnosno da se ustanovi koji tehnološki postupak dorade daje optimalne rezultate. Relevantni parametri koji su praćeni tokom ispitivanja bili su: čisto seme (%), seme korova i seme drugih kultura (%), inertne materije (%), količina dorađenog semena (kg), vreme dorade semena (min), utrošak čeličnog praha (kg), vode (l), glicerina (ml) i randman dorade (%). Lucerka predstavlja najznačajniju krmnu leguminozu kako po kvalitetu krme, tako i po površinama na kojima se gaji u našoj zemlji i u svetu. Gubici semena lucerke pri doradi su u direktnoj zavisnosti od vrste i količine korova i ostalih nečistoća prisutnih u naturalnom semenu. Naročito velika količina primesa i korova u naturalnom semenu lucerke može biti posledica lošeg stanja useva, kao i neodgovarajućeg podešavanja kombajna u procesu žetve. Proces dorade semena lucerke se izvodi na više mašina i uređaja, što podrazumeva niz različitih postupaka u zavisnosti od ulazne čistoće semena. Koje mašine će se primeniti za proces dorade, kao i izbor odgovarajućeg tehnološkog postupka zavisi od početne čistoće semena. Takođe je značajno i pravilno podešavanje mašina za doradu da bi se dobili optimalni rezultati i smanjili gubici semena prilikom procesa dorade.

Ključne reči: *lucerka, seme, tehnologija dorade.*

INTRODUCTION

Due to high productivity and excellent nutritional value of the forage, alfalfa is considered the most important and leading forage crop in the world, as well as in our country (*Barnes et al., 1988; Burton, 1972; Lugić et al., 2000; Lukić, 2000*). It has been grown on 35 mil ha throughout the world (*Barnes et al., 1988*) and in 2010 on 187.079 ha in the Republic of Serbia (*Statistical yearbook of the Republic of Serbia, 2011)*.

In order to establish and exploit alfalfa, the seed has to be of high purity value, germination, as well as of high genetic value. Alfalfa seed has a big economic value and represents significant goods on domestic and foreign markets (*Katić et al., 2000; Mišković, 1986; Stanisavljević, 2006*). Due to its fine physical and chemical features, alfalfa seed can be easily transported from one region to another. If it is properly stored, it reaches the best germination value over a 2-5 year period (*Radenović, 2000; Tomić et al., 1998*).

During alfalfa harvest, the obtained material consists of a seed mixture of grown plants, other crops and weeds, as well as various impurities of organic and inorganic origin. The proper combine adjustments and care measures taken during the transport insure that the grain is harvested with minimum loss. Prior to harvest, the approbation of the yield should be carried out, but there are often a lot of weeds and large quantities of impurities observed in the harvested seeds. Such seeds undergo processing which decreases the quality of natural seeds and makes the processing of alfalfa more difficult. The natural seed purity depends on the condition of the crops and harvesting operations. Crop purity is, actually the relation between quantities of clean seeds of basic crop and other crops, weeds and inert matters. Depending on weather conditions over the year, the average natural seed purity ranges from 66.0% (*Katić et al., 2000*) to 73.5% (*Erić et al., 1993*). When the harvest conditions are extremely poor, with weedy and lodged plants, the seed purity value may be lower than 30.0% (*Karagić et al., 2007*).

Cleaning the seeds has two purposes: eliminating the seeds of other cultures and inert matters, and obtaining the final product seeds while disposing the seeds of inadequate weight, colour, odour and health. By seed processing, the maximum percentage of clean and highly genetically potential seed is obtained (*Copeland and McDonald, 2004; Kolak, 1990*). The significance of processed seed is in its timely and best possible preparation for qualitative sowing, germination and growing. Seed processing is based on seed physical characteristics. Prior to every processing, a careful analysis of every set of seeds should be done, which will, together with a proper combination of equipment give the optimal results (*Smith 1988; Copeland and McDonald, 2004; Black et al., 2006, Babić and Babić, 1998*). It is highly important that during processing alfalfa, the discrepancy between the amount of clean seed estimated in a laboratory and an actual amount of obtained seed in a processing centre, should be as small as possible (*Savić et al., 2000; Đokić, 2010*). The smaller the discrepancy the more efficient is the equipment. During the processing, seed losses are directly related to the amount of impurities in natural seeds, amount and sort of weeds (*Đokić et al., 2009; Đokić, 2010; Đokić et al., 2011*). In order to make processing most effective, the proper equipment and adequate technology should be applied. That way it is possible to obtain the optimal amount of seeds of suitable quality in the shortest period of time.

The processed seed quality must satisfy the laws and regulations on seed material. The Law on Seed and Planting Material (*The Official Gazette of the Republic of Serbia, 45/2005*) which is in accordance with the international regulation of seed research (*ISTA, 1999*), defines the conditions and means of seed production, processing and distribution. According to the Law on seed, the least accepted alfalfa seed purity is 95% with no more than 2% of other crops, 0.5% of weeds (free of quarantine weeds) and 2.5% of inert matters, 70% of germination with 13% of seed humidity (*The Official Gazette of the SFRJ, 47/1987*). Larger amounts of harmful weeds in the natural alfalfa seed decrease the overall amount of processed seed, making the processing more expansive and more difficult.

MATERIAL AND METHOD

The research was carried out at the processing centre of The Institute for Forage Crops in Globoder-Kruševac. In three repetitions, natural alfalfa seed of 59.0% and 71.0% purity was processed by two different sets of equipment, using two technological methods. The quantity of seed in each pass was 300 kg, i.e. 900 kg for each purity value (1800 kg in total).

The first processing set used the standard equipment which consisted of the following items: intake pit with belt conveyor, belt conveyors, bucket elevators, fine cleaning machine by Danish manufacturer Damas-type Alfa-4, indented cylinders by Danish manufacturer Damas (with three rollers)-type Hotyp, and magnetic separator by German manufacturer Emceka Gompper-type 4. The second set of equipment, which was used for processing the seed of higher purity value, was the same as the first one with the exception of indented cylinders. The first method (in which the 59% purity value seed was used) was a standard alfalfa processing method by which the seeds are mixed with water and iron powder in certain proportion, in the magnetic separator mixer. The second method (in which the 71% purity seed was used) contained a certain quantity of glycerin dissolved in water apart from the two components used in the first method. As for iron powder, it was an American brand Nutra Fine RS.

Natural alfalfa seed S1 (table 1) purity value was 59%, on average. As for other plants, in the sample, only seeds of red clover (*Trifolium pratense* L.) could be found in traces. These seeds had a high percentage of inert matters (39.3%) such as pods, sick grains and harvest residues. The average content of weeds in alfalfa seeds was low (1.7%) with four grains of dodder (*Cuscuta* spp.), in a sample of 5 g. There was also a certain number of field bindweed (*Convolvulus arvensis*), red-root pigweed (*Amaranthus retroflexus* L.) and wild carrot (*Daucus carota* L.) seeds. Natural alfalfa seed S2, of 71% purity value, contained 29% of inert matter, mostly sick grains, harvest residues and soil with 5 grains of dodder, in a sample of 5 g. (table 1)

Table 1. Average purity of S1 and S2 alfalfa seed

Bulk alfalfa seed				
Purity	S1		S2	
Content	%	Weed species	%	Weed species
Pure seed	59.0		71.0	
Weed	1.7	*Convolvulus arvensis*, *Amaranthus retroflexus* L., *Daucus carota*, 4 *Cuscuta* spp./5 g	0	5 *Cuscuta* spp./5 g
Other species	0	red clover (traces)	0	
Inert matter	39.3	pods, sick grain, harvest residues	29.0	sick grain, harvest residues, soil

The analysis of the contents of impurities in seed samples (5 g and 50 g) was conducted under laboratory conditions by using electronic scales and illuminated magnifying glass. Measuring the mass of processed seed was performed using electronic scales measuring range up to 300 kg. The processing time was measured by a stopwatch. During the examination, the following parameters were measured: pure seed (%), seed of other crops (%), inert matter (%), weed seed (%), the amount of processed seed (kg), seed processing time (min), processing output (%). Based on these parameters and the comparison of average values, it is evident which of the processing equipment sets and technological methods were optimal, that is, which sets yield the best quality and the largest amount of pure seed in the shortest period of time.

RESULTS AND DISCUSSION

The average values of alfalfa seed purity S1 processed by first equipment set are shown in table 2.

Table 2. The average purity of S1 alfalfa seed in relation to processing stage

Content	%	Weed species
Seed purity S1 (sample from the intake pit)		
Pure seed	59.0	
Other species	0	red clover (*Trifolium pratense* L.) in traces
Inert matter	39.3	pods, sick grains, harvest residues
Weed	1.7	*Convolvulus arvensis*, *Amaranthus retroflexus* L., *Daucus carota* L., 4 *Cuscuta* spp. in 5 g
Seed purity S1 after first pass through equipment (sample from big seed hopper)		
Pure seed	88.3	
Other species	0	
Inert matter	11.5	sick grains, harvest residues and damaged grain
Weed	0.2	*Daucus carota* L., *Cuscuta* spp.
Seed purity S1 after the second pass through equipment (sample from mixer)		
Pure seed	94.7	
Other species	0	
Inert matter	5.3	sick grain, damaged grain
Weed	0	
Seed purity S1 after pass through magnetic separator (sample from bag)		
Pure seed	96.9	
Other species	0	sick grain
Inert matter	3.1	
Weed	0	

After the first pass through the equipment, the seed purity S1 (Table 2) was 88.3% with 11.5% of inert matters. Dodder seeds were found in the sample of 5 g. That was why the seeds were, after the first pass, directed into the big seed hopper and then again into the intake pit for another processing. After the second pass through the equipment, the sample came out free from quarantine dodder and curly dock seed. According to technological processing scheme, the seeds are, by means of the diverter valve, directed to a pit above the mixer of magnetic separator. The seeds are then released into the mixer in which they are being mixed with iron powder and water. After mixing, seed goods are being transported by the bucket elevator into a bunker above the magnetic rolls. Average seed purity after processing on magnetic separator was 96.9%, while the rest 3.1% was inert matter of sick grains. The weeds were found neither in the sample of 5 g nor in the sample of 50 g, which implies that the seeds of purity value S1 processed on this equipment satisfied the law abiding norms.

During processing of alfalfa seed S1 on the sieves of the fine cleaning machine Alfa-4 on the lower indented cylinders, a certain amount of quality alfalfa seed is thrown out with impurities. In order to increase the percentage of seed exploitation these seeds are collected in sacks and at the end of the processing returned again into the intake pit to be processed one more time. An average waste seed quality is shown in Table 3. The seed from waste has a high percentage of clean seed (83.0%), as well as dodder seed in a sample of 5 g (27 grains). The seed from waste is processed by the same machines and by the same technological method as the natural seed from which the waste is obtained. After the first pass through equipment, the analysis is carried out on the sample of 5 g. The results show an increase of 5.5% in purity value and riddance of all weed species. The percentage of inert matters (sick and damaged grains) is also decreased but still pretty high (11.5%). In order to increase the percentage of clean alfalfa seed and decrease the percentage of inert matter of sick and grains, the seed is, after first pass through equipment, directed to a bunker above the mixer of magnetic separator. In a mixer pit seed is mixed with certain quantity of iron powder and water, and then transported by a bucket elevator to a bunker above magnetic rolls and then to magnetized rolls.

Table 3. Processing of alfalfa seed purity S1 from waste

Content	%	Weed species
Seed purity S1 from waste (sample from the intake pit)		
Pure seed	83.0	
Other species	0	
Inert matter	14.7	sick grain, harvest rests
Weed	2.3	27 *Cuscuta* spp. in 5 g, *Amaranthus retroflexus* L.
Seed purity S1 after first pass through equipment (sample from mixer)		
Pure seed	88.5	
Other species	0	
Inert matter	11.5	sick grain, damaged grain
Weed	0	
Seed purity S1 after pass through magnetic separator (sample from bag)		
Pure seed	96.5	
Other species	0	
Inert matter	3.5	sick grain
Weed	0	*Daucus carota* L.

After the processing by a magnetic separator, the analysis of the seed sample of 50 g by a small magnetic separator for the presence of dodder, and a sample of 5 g for purity value showed that the seed had fitting purity 96.5%, according to the law regulations.

Table 4 shows the average values during processing alfalfa seed of purity S2 on different equipment and by different method.

Table 4. The average purity of alfalfa seed S2 in relation to processing stage

Content	%	Weed species
Seed purity S2 (sample from the intake pit)		
Pure seed	71.0	
Other species	0	
Inert matter	29.0	sick grain, harvest residues, dirt
Weed	0	5 *Cuscuta* spp. in 5 g
Seed purity S2 after first pass through equipment (sample from mixer)		
Pure seed	89.5	
Other species	0	
Inert matter	10.5	sick grain, damaged grain
Weed	0	4 *Cuscuta* spp. in 5 g
Seed purity S2 after pass through magnetic separator (sample from bag)		
Pure seed	97.2	
Other species	0	
Inert matter	2.8	sick grain
Weed	0	

During the second technological method in which glycerine was used in a processing mixer, the seed is processed in one pass through the equipment and magnetic separator. The purity values, depending on a processing phase, are shown in Table 4. After processing, the seed purity value increases from 89.5% to 97.2%, owing to magnetic separator, with only 2.8% of inert matter with sick grains, free of weeds, which was in accordance to law regulations. By processing alfalfa seed of 71.0% purity, applying the second technological method, 5.0 ml of glycerin was used for 1.2 l of water. It had previously been dissolved in water and then, in the mixer, dosed accordingly. Due to large quantity of inert matters and weeds in the waste from the fine cleaning machine, the waste wasn't processed. The average values of all relevant parameters obtained after the processing of seed of 59.0% and 71.0% purity on two different equipment sets are shown in table 5.

Table 5. The average processing time, iron, powder, water and glycerin consumption, average quantity of processed seed, output of processed seed during the alfalfa seed processing technology

Processing technology		1	2
Processing time (min)		220.0	87.0
Consumption	Iron powder (kg)	1.1	1.6
	Glycerin (ml)	-	11.5
	Water (l)	2.8	2.8
Processed seed (kg)	From processing	135.7	219.5
	From waste	29.3	0
	Total	165.0	219.5
Processing output (%)		55.0	73.17

Analyzing the obtained data in Table 5 by processing alfalfa seed of different purity value using two different sets of equipment and using two different technological methods, the results show considerable differences in seed S1 with purity value of 59.0% compared to seed S2 with purity value of 71.0%. All the relevant parameters have notably decreased. The processing time in seed of lower purity, processed on the first set of equipment, was 220.0 min. In the seed S2 with higher purity value, processed on the second set of equipment and using another method, the processing time was 87.0 min., which is 2.53 times shorter. The time spent on more seed passes, as well as on processing seed waste of lower purity value seed, considerably increased overall processing time. In the use of the second set of equipment, by processing seed of purity value S2, the consumption of iron powder was greater by 0.5 kg, while output of processing was higher by 18.17% compared to lower purity value seed. As far as the quantity of seed is concerned, there were 54.5 kg (33.0%) more of processed seed of S2 purity in comparison with the seed of purity S1.

CONCLUSION

Based upon the research results, it can be concluded that processing natural alfalfa seed of different purity value by different sets of equipment and methods, all the relevant parameters are considerably different and depend on the applied technology, as well as on initial purity value. In processing the seed of different purity value and using different technological methods, distinctions were particularly notable in the processing time, the quantity of processed seed and the output of processing. Applying glycerin during the second technological method with seed of higher purity value, the processing time was shorter compared to standard method applied in processing seed of lower initial purity value. The average processing time with the second technological method was 2.53 times shorter, which saves us a lot of processing time. Also, the consumption of such seed is higher, i.e. larger quantities of seed were obtained which was another indicator of effectiveness of this processing method. By processing the seed with lower percentage of traces in natural seed, 54.5 kg more of processed seed were obtained in comparison with the seed of lower initial purity value.

The content of inert matters in alfalfa seed depends on several factors: combining quality, i.e. functioning, preparation and settings of combine, as well as on combiner's efficiency during combining. The timely and proper preparation, proper setting and combine exploitation have a considerable effect on the quantity of yield and quality of harvested grains. A small absolute mass of alfalfa seed, high resemblance in shape and size of weeds with alfalfa seed, high percentage of quarantine weeds, bad combine setting which leads to high percentage of inert matters in alfalfa seed, call for utmost comprehension of alfalfa seed characteristics, weeds and other species as well as technical features of equipment. By using an appropriate technological processing method with seeds of lower percentage of impurities, decreasing the processing time and increasing the overall quantity of processed seed, the power consumption is also decreased which leads to lower seed price.

According to all indicators, by choosing the appropriate technological methods and equipment, the processing was improved, i.e. an optimization and rationalization were achieved in the process of alfalfa seed production.

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