Original scientific paper
10.7251/AGRENG1902005D
UDC 631.53.01: 633.31

THE INFLUENCE OF DIFFERENT PURITY OF NATURAL ALFALFA SEEDS ON THE PROCESSING EFFICIENCY

Dragoslav ĐOKIĆ[1*], Rade STANISAVLJEVIĆ[2], Dragan TERZIĆ[1], Jasmina MILENKOVIĆ[1], Goran JEVTIĆ[1], Ratibor ŠTRBANOVIĆ[2], Ranko KOPRIVICA[3]

[1]Institute for Forage Crops, 37251 Globoder-Kruševac, Republic of Serbia
[2]Institute for Plant Protection and Environment, Teodora Drajzera 9, 11000 Belgrade, Republic of Serbia
[3]University of Kragujevac, Faculty of Agronomy, Cara Dušana 9, 32000 Čačak, Republic of Serbia
*Corresponding author: dragoslav.djokic@ikbks.com

ABSTRACT

This paper presents the results of the seed processing of ten lots of natural alfalfa seed with different purity (from 68.0% to 86.5%). The test was carried out at the seed processing center of the Institute for forage crops Kruševac-Serbia. Seed losses, processing output, seed yield and quality of the processed seed were investigated. It is important that the difference between the amounts of pure seed from laboratory assessment and the actual amount after processing, are low. The purity of natural alfalfa seed depends on the crop condition and the harvest process. In the seed processing of small-grained leguminous plants, the processing output of seed is directly dependent on the percentage of weed species and other species in the natural seed. Seeds of quarantine weeds of dodder and curly dock are a particularly big problem in alfalfa seeds. In the case of high-purity seeds with low quarantine weeds share, processing output are high. By the legal procedure on the seed quality, the content of pure seed, inert materials, weeds and other species in the processed seeds is defined. The efficiency of the alfalfa seed processing depends on the initial purity of the seed, as well as the applied technical and technological process of seed processing. Based on the obtained results, it is possible to optimally adjust and select the appropriate equipment for the processing of alfalfa seed, depending on the quantity and type of weeds and other ingredients in the natural alfalfa seeds.

Keywords*: alfalfa, purity, processing, seed, weeds.*

INTRODUCTION

Alfalfa (*Medicago sativa* L.) is often called the "Queen of forage crops". It is characterized by extreme flexibility. Alfalfa is a plant with an efficient source of nitrogen and high production of biomass (Barnes et al., 1988). In the region of Southeast Europe alfalfa is the most important perennial forage legume. In this

region fodder is mainly dried after cutting and hay is used for animal nutrition (Knežević et al., 2014). Alfalfa requires neutral soil. In animal feed alfalfa can be used fresh or conserved as hay, haylage, silage, flour, pellets, and paste (Jakšić et al., 2013; Jakšić et al., 2017). Alfalfa is one of the best and most important forage species according the vitamin and mineral content (large amounts of pro-vitamin A, vitamins B_1, B_2, C, D, E, K). There is about 20% crude proteins in dry matter of alfalfa (Vučković, 1999). Except to the forage, alfalfa is also used for the seed production. By cultivating alfalfa seed, with the appropriate technology it is possible to achieve high yields and very good financial effects (Đokić at al., 2015).

Serbia's climate is judged to be moderately favorable for the production of seed legumes. The average yield of alfalfa and red clover seeds is about 250 kg ha^{-1} (Karagić et al., 2010). In the modern production of plant species, one of the prerequisites for achieving high and stable yields, as well as for approaching the realization of maximum genetic yield potentials, is the use of high quality seeds (Mladenov and Milošević, 2011). The purity of natural alfalfa seeds is different, which significantly affects the seed losses during the seed processing. The task of seed processing is to prepare the quality seed for sowing, with satisfied germination and sprouting (Đokić et al., 2012; Đokić et al., 2016). Seed processing is based on the physical characteristics of the seed and therefore it is necessary to carefully analyze all seed features and to do the appropriate adjustment of the equipment (Babić and Babić, 1998; Black et al., 2006; Copeland et al., 2004; Đokić, 2010; Đokić and Stanisavljević, 2012).

In the seed crop of alfalfa, the most damaging quarantine weeds are dodder and curly dock. The dodder (*Cuscuta* spp.) can cause enormous damage especially if no suppression is done. It is one of the most dangerous and economically most damaging weeds (Čuturilo and Nikolić, 1986; Đukić at al., 2004; Miladinović, 2001).

The Law on Seeds of the Republic of Serbia defines the conditions and manner of production, processing, use, trade, import and testing of the quality of seeds of agricultural plants (Official Gazette of the Republic of Serbia, 45, 2005). The Rulebook on the Quality of Seeds of Agricultural Plants (Official Gazette of the SFRY, 47/1987), which is harmonized with international seed regulations (ISTA, 1999) defined the quality standard for the quality of seeds of alfalfa. According to this Rule, the alfalfa seed (*Medicago sativa* L.) must have a minimum seed purity of 95%, with 2% of seeds of other species, weeds not more than 0.5% (including dodder and curly dock), and up to 2.5% inert materials.

The aim of this study was to analyze the influence of different purity of alfalfa seed on the efficiency of seed processing. On the basis of the obtained results, it is possible to optimize the selection of the appropriate alfalfa seed processing equipment, depending on the quantity and type of weeds and other ingredients in the natural seed of the alfalfa.

MATERIAL AND METHODS

The experiment was carried out at the processing center of the Institute for Forage Crops in Kruševac-Serbia. In three replications the ten lots of natural alfalfa seed with different purity was processed. The purity of natural alfalfa seed ranged from a minimum of 68% to a maximum of 86.5%. The processing equipment was Danish manufactures of Kongskilde and Damas, and magnetic separator type 4 of the German manufacturer Emceka Gompper.

To clean alfalfa seed favorable combination schedule screens on the machine for fine cleaning of seed was established. In the upper shaker shoe were located sieves and sieve with round holes of the following diameters: 2.75 mm; 2.5 mm; 2.25 mm; 2.0 mm; 2.0 mm and 1.9 mm. At the bottom of the shaker shoe was in the sieve with longitudinal-cut openings width: 1.3 mm; 1.2 mm; 1.1 mm; 0.6 mm; 0.5 mm and 0.5 mm.

In order to analyze the content of foreign matter in the seed, a laboratory lamp with light and precision electronic scale was used. Samples for analysis were weighing 5 g and 50 g. Measurement of the mass of the processed seed was carried out using electronic weighing range of up to 300 kg. In each of the repetitions by laboratory analysis, the following parameters were measured: quantity of pure seed (%), seed of other species (%), inert matter (%), weed (%), and amount of processed seed (kg). Processing output (%) and seed losses on processing equipment (%) were determined by calculation.

The obtained results were analyzed by variance analysis (ANOVA), and the significance of the mean difference was tested with the Tukey test. The statistical program Minitab 16.1.0 (statistics software package) was used for data processing.

RESULTS AND DISCUSSION

The purity of the natural seed of the alfalfa of all ten seed lots is shown in Table 1. The presence of other plant species has not been established by analysis of the samples. The investigated natural alfalfa seed had a purity ranging from the lowest values of 68.0% in the seed lot I to the highest purity of 86.5% for the seed lot II. Seed lots II, VII, VIII, and X had higher purity of natural seed than lot I (Table 1). Inert substances are present in the form of harvest residues (stems, leaf, and other legumes), soil, sickly grain and damaged seed. The content of inert materials was from 12% for seeds of lot II to a maximum content of 27.2% for seed lot I. The presence of inert materials in alfalfa seed does not pose a greater problem in the process of finishing, except when there is a greater share of incomplete pods (Đokić, 2010). The content of weeds in the native alfalfa seed was 1.0% in the seed lot VII to 8.0% in lot VIII. From weeds in natural seed of alfalfa by analysis of samples, seeds of dodder were found in all seed lots, except for the lots I and VIII, where the seeds of dodder were not found. The largest number of dodder was 20 seeds (in a 5 g sample) in the lot II. The smallest number of dodder was 2 seeds (in a 5 g sample) in the lots IV and IX. In the analysis of the weed seed of the lot VII, seed of sorghum was found, and in the lot VIII seed of green foxtail was found.

Table 1. The average purity of natural alfalfa seeds

Lot	I	II	III	IV	V	VI	VII	VIII	IX	X
Seed structure	%	%	%	%	%	%	%	%	%	%
Pure seed	68.0 b	86.5 a	76.0 ab	75.5 ab	72.0 ab	72.5 ab	86.0 a	78.0 a	76.0 ab	81.0 a
Other species	-	-	-	-	-	-	-	-	-	-
Inert matter	27.2 a	12.0 b	18.5 ab	23.7 ab	23.4 ab	26.0 a	13.0 b	14.0 b	18.8 ab	17 ab
Weed	4.8 b	1.5 c dodder 20/5 g	5.5 b dodder 6/5 g	0.8 c dodder 2/5 g	4.6 b dodder 16/5 g	1.5 c dodder 5/5 g	1.0 c dodder 10/5 g	8.0 a	5.2 b dodder 2/5 g	2 bc dodder 6/5 g
Total	100	100	100	100	100	100	100	100	100	100

Tukey test statistical significance levels: $p \leq 0.05$, differences in row marked in small letters a, b, c...

The natural seed is transported from the receiving bunker to the fine-cleaning machine type Alfa-4 by a system of bucket and belt conveyors. The alfalfa seed is transported to a large bunker for seed reception after processing on a fine-cleaning machine with bucket conveyors. From the hopper the seed is inserted into a mixer where, at a certain time and in a certain proportion, it is mixed with steel powder and water. Nutra Fine RS steel powder was used for mixing alfalfa seed. Magnetic separator serves for the separation of weed species, especially the seeds of the dodder. The purity of alfalfa seed after processing and passing through the equipment is shown in Table 2.

Table 2. The average purity of processed alfalfa seeds

Lot	I	II	III	IV	V	VI	VII	VIII	IX	X
Seed structure	%	%	%	%	%	%	%	%	%	%
Pure seed	98.2 ab	99.6 a	99.0 a	97.4 b	98.2 ab	97.4 b	98.4 ab	97.8 b	97.6 ab	98.2 ab
Other species	-	-	-	-	-	-	-	-	-	
Inert matter	1.8 b	0.4 c	1.0 bc	2.6 a	1.0 bc	2.6 a	1.6 b	1.8 b	2.4 a	1.8 b
Weed	-	-	-	-	0.8	-	-	0.4	-	-
Total	100	100	100	100	100	100	100	100	100	100

Tukey test statistical significance levels: $p \leq 0.05$, differences in row marked in small letters a, b, c...

After the seed processing the purity of all ten seed lots was high and ranged from the lowest values of 97.4% in the seeds of the lots IV and VI to the highest values of 99.6% in the lot II. Seed lots II and III also achieved a statistically significant ($p \leq 0.05$) purity compared with lots V and VIII (Tab. 2). The content of inert matters ranged from the lowest value of 1% for seeds lot V, up to a maximum of 2.6% for seed lots IV and VI. A detailed analysis of the processed seeds in the lot I founded 2 seeds of orchard grass (*Dactylis glomerata* L.) in 50 g sample. In the seed lot II (50 g sample), there were 3 seeds of pigweed (*Amaranthus retroflexus*).

In the lot III, there were 2 seeds of curly dock (*Rumex* spp.), 9 seeds of chamomile (*Matricaria chamomilla*), 1 seed of green foxtail (*Setaria* spp.*)*, and 1 seed of Sudanese grass (*Sorghum sudanense* Pers.). In the lot IV, there were 4 seeds of curly dock (*Rumex* spp.). The sample of seed lot VI had 3 seeds of red clover (*Trifolium pratense* L.), 3 seeds of pigweed (*Amaranthus retroflexus*) and 2 seeds of foxtail (*Setaria* spp.). Part VII was in the sample with 1 wild carrot seed (*Daucus* spp.), 5 seeds of foxtail (*Setaria* spp.), 1 seed of pigweed (*Amaranthus retroflexus*) and 3 seeds of red clover (*Trifolium pratense* L.). In the seed sample of lot X (50 g sample) there were 1 seeds of curly dock (*Rumex* spp.) and sorghum (*Sorghum* spp.) in traces.

At the end of the seed processing the amount of processed seed was measured. The quantities of natural seed of the alfalfa of all ten lots at the beginning of the seed processing and the amount of processed seeds at the end of the seed processing are shown in Table 3. Also, processing output and seed losses are shown in Table 3. Amount of the natural and recovered seed of lot X was significantly higher ($p \leq 0.05$) than in the other lots. Processing output in the lot VII was significantly higher than in the other lots ($p \leq 0.05$), but not statistically significant than in the lots II and X. Seed losses were significantly higher for lots V and IX (Table 3).

Table 3. Amounts of proceseed alfalfa seeds on processing machines

Seed structure	Lot									
	I	II	III	IV	V	VI	VII	VIII	IX	X
Natural seed (kg)	794 e	1260 de	990 ef	1412 d	660 e	1107 e	2025 bc	1900 c	2250 b	8000 a
Processed seed (kg)	520 bc	900 b	690 bc	970 b	343 c	760 bc	1633 b	1300 b	1300 b	5896 a
Processing output (%)	65.5 b	71.4 ab	69.7 b	68.7 b	51.9 b	68.6 b	80.6 a	68.4 b	57.7 ab	73.7 ab
Losses (%)	3.7 d	17.4 b	8.3 ce	9.0 dc	27.8 a	5.3 dc	6.2 dc	12.3 c	23.9 a	9.0 dc

Tukey test statistical significance levels: $p \leq 0.05$, differences in row marked in small letters a, b, c...

By analyzing the results obtained after the alfalfa seed processing it was noted that the processing output was different. It ranged from at least 51.9% of seed lot V, while the highest was in seed lot VII (80.6%). Seed lot VII also had a high initial purity of natural seed of 80.0%. Seed losses were also varied and ranged from the lowest loss of 3.7% for seeds of lot I to the highest seed losses lot V (27.3%). High seed losses were also in the seed lot IX (23.9%).

CONCLUSION

By seed processing on a magnetic separator, using steel powder and water, high purity and quality seed was obtained. After the seed processing of ten lots of natural alfalfa seed, seed purity was high and ranged from 97.4% in the seeds of the IV and VI lots to 99.6% in the seeds of lot II. The content of inert substances was from the lowest value of 1% for seeds of lot V, up to a maximum of 2.6% for

seeds of lots IV and VI. Seed losses were varied and ranged from the lowest losses of 3.7% for seeds of lot I to the largest losses in lot V and amounted to 27.3%. Significant seed losses were also found in lot IX and amounted to 23.9%. Processing output had the lowest value in the seed lot V (51.9%), up to the largest in seed lot VII (80.6%).

ACKNOWLEDGMENT

This study was supported by the Ministry of Education, Science and Technological Development of the Republic of Serbia, Project No TR – 31057.

REFERENCES

Babić, M., Babić Lj. (1998). Uticaj osnovnih fizičkih osobina semena pšenice na karakteristike strujanja vazduha. Selekcija i semenarstvo, 5(3-4): 29-32. (The influence of the basic physical properties of wheat seed to the characteristics of the airflow. Plant Breeding and Seed Production, 5(3-4): pp. 29-32).

Barnes, K., D., Goplen, B., P., Baylor, J., E., (1988). Alfalfa and Alfalfa Improvement. Highlights in the USA and Canada, ch. 1, 1-24. ASA, CSSA, SSSA. Medison, Wisconsin, USA.

Black M., Bewley J., Halmer P. (2006). The Encyclopedia of Seeds Science, technology and uses. Wallingford, UK.

Copeland, Lawrence O., McDonald, Miller, (2004). Seed Drying. Seed Science and Technology, Norwell, Massachusetts, pp. 268– 276.

Čuturilo S., Nikolić B. (1986). Korovi lucerke i njihovo suzbijanje. Beograd, Nolit. (Alfalfa weeds and their suppression. Belgrade, Nolit).

Đokić D. (2010). Primena različitih tehničko-tehnoloških sistema u doradi semena lucerke. Doktorska disertacija, Univerzitet u Beogradu. Poljoprivredni fakultet, Beograd. (Application of diverse technological systems in the alfalfa seed processing. Doctoral dissertation, University of Belgrade. Faculty of Agriculture, Belgrade).

Đokić D., Stanisavljević R. (2012). Possibility of Improving Seed Processing of Red Clover (*Trifolium pratense* L.) and Alfalfa (*Medicago sativa* L.). Book of the proceedings International Conference on BioScience: Biotechnology and Biodiversity – Step in the Future – The Forth Joint UNS – PSU Conference, June 18-20, Novi Sad, Serbia, pp. 135-148.

Đokić D., Stanisavljević R., Terzić D., Milenković J., Radivojević G., Koprivica R., Štrbanović R. (2015). Efficiency of alfalfa seed processing with different seed purity. Journal on Processing and Energy in Agriculture, 19(3), pp. 166-168.

Đokić D., Stanisavljević R., Terzić, D., Milenković, J., Lugić, Z., Radivojević, G., Barać S. (2016). Kvantitativni i kvalitativni pokazatelji efikasnosti dorada semena lucerke. XXI Savetovanje o biotehnologiji sa međunarodnim učešćem. Čačak, 11-12 mart. Zbornik naučnih radova, Vol. 21(23), 105 - 110. (Quantitative and qualitative indicators of efficiency processing of alfalfa. XXI

Symposium on biotechnology with international participation. Čačak, March 11-12. Vol. 21(23), pp. 105 – 110).

Đukić D., Moisuc A., Janjić V., Kišgeci J. (2004). Krmne, korovske, otrovne i lekovite biljke. Novi Sad, Poljoprivredni fakultet. (Forage, weed, poisonous and medicinal plants. Novi Sad, Faculty of Agriculture).

Glasnik Republike Srbije br. 45, 2005. (Official Gazette of the Republic of Serbia, 45, 2005).

ISTA-International Rules for Seed Testing, (1999). Seed Science and Technology, 27, Supplement. p. 1 – 333. Basserdorf, Switzerland.

Jakšić S., Vučković S., Vasiljević S., Grahovac, N., Popović V., Šunjka D., Dozet G. (2013). Akumulacija teških metala u *Medicago sativa* L. i *Trifolium pratense* L. na kontaminiranom fluvisolu. Hemijska industrija, 67(1), 95-101. (Accumulation of heavy metals in *Medicago sativa* L. and *Trifolium pratense* L. at the contaminated fluvisol). Chemical Industry. 2013, Vol. 67 Issue 1, pp. 95-101).

Jakšić S., Vasin J., Ninkov J., Živanov M., Banjac D., Grahovac N., Dozet G. (2017). Uticaj tipa zemljišta i krmnog useva na sadržaj mangana u kabastoj stočnoj hrani. Ratarstvo i povrtarstvo. Zbornik radova Instituta za ratarstvo i povrtarstvo Novi Sad, Vol. 54, br. 1, str. 31-35. (Effect of Soil Type and Forage Crop on Manganese Content in Roughage. A journal of field and vegetable crops research. Proceedings of the Institute of Field and Vegetable Crops Novi Sad, Vol. 54, No. 1, pp. 31-35).

Karagić Đ., Jevtić G., Terzić D. (2010). Forge legumes seed production in Serbia. Biotechnology in Animal Husbandry. Publisher: Institute for Animal Husbandry, Belgrade-Zemun, 26 (spec. issue), book 1: 133-148.

Knežević J., Aksić M., Ćirić S., Stević, V., Tomić D., Stanisavljević R. (2014). Application of cornmeal at ensiling of alfalfa cocksfoot and their mixture. Acta Agriculturae Serbica, Vol. XIX, 38; 143-150.

Miladinović M. (2001). Proizvodnja semena krmnog bilja. Naučni institut za ratarstvo i povrtarstvo Novi Sad. (Seed production of forage crops. Scientific Institute of Field and Vegetable Crops Novi Sad).

Mladenov V., Milošević M. (2011). Uticaj sorte i lokaliteta na kvalitet semena ozime pšenice. Selekcija i semenarstvo, XVII (1), 83-95. (The influence of variety and location on seed quality of winter wheat, Plant Breeding and Seed Production, XVII (1), 83-95).

Službeni list SFRJ br. 47, 1987. (Official Gazette of the SFRY, 47, 1987).

Vučković S. (1999). Krmno bilje. Beograd: Institut za istraživanje u poljoprivredi "Srbija", Nova Pazova "Bonart". (Forage crops. Belgrade: Institute for Agricultural Research "Serbia", Nova Pazova "Bonart").