THE INFLUENCE OF IMPURITIES IN NATURAL SEEDS OF ALFALFA AND RED CLOVER ON THE SEED CLEANING PROCESS

ABSTRACT

The paper presents the results of the cleaning process of five different lots of natural alfalfa seeds and five different lots of natural red clover seeds. Natural alfalfa and red clover seeds had 75 % to 77 % purity. The experiment was performed in the seed processing center of the Institute for Forage Crops Kruševac. Seed cleaning is performed on different machines that work on the principle of differences in the physical properties of seeds. Significant parameters that define the quality of seeds after processing on the cleaning equipment are the amount of pure seed, weed seed, the seed of other crops, inert matter, amount of pure processed seed, seed losses and processing output. The obtained results enable the correct adjustment of the equipment for the seed processing, depending on the amount and type of seeds and other impurities found in the natural seed of alfalfa and red clover.

Keywords: impurities, alfalfa, red clover, equipment, cleaning.
processing equipment, it is possible to obtain large quantities of quality seed in a short time according to the prescribed seed standards (Dokić et al., 2013; 2017; 2018; 2019 a; 2019 b). The size of the openings on the sieves of the fine cleaning machine should be taken into account, due to the size of the seeds (Erić et al., 1996). In the forage crops, weed species contaminate the seeds and make harvesting and processing more difficult. The presence of two quarantine weeds, dodder (Cuscuta sp) and curly dock (Rumex sp), is particularly harmful. Dodder (Cuscuta sp) is one of the most dangerous and economically harmful quarantine weeds on plots under red clover and alfalfa crops because it causes huge damage to crops (Dokić et al., 2004; Karagić et al., 2007; Dokić et al., 2016). The Law on Seeds and Planting Material prescribes all conditions related to the method of production, processing, use, trade, import and testing of seeds of agricultural plants (Gazette of the Republic of Serbia no. 45, 2005). The quality of alfalfa and red clover seeds should correspond to the Ordinance on the quality of seeds of agricultural plants (Gazette of SFRJ no. 47, 1987). Processed seeds of these two plants must have: the lowest purity of 95 %, 2 % of seeds of other species, weeds of 0.5 % (without weeds of Cuscuta sp), up to 2.5 % of inert substances, maximum moisture of 13 %, and minimum germination of 70 %.

The aim of this study was to determine the influence of impurities in natural alfalfa and red clover seeds on the seed cleaning process. The basic indicators of machine efficiency in the seed cleaning process were the quality and quantity of seeds obtained at the end of the seed cleaning process.

MATERIAL AND METHOD

The experiment of cleaning alfalfa and red clover seeds was performed in the seed processing center of the Institute for Forage Crops Kruševac. In three replications, five lots of natural alfalfa seed and five lots of natural red clover seed were processed. The content of inert substances, as well as the amount and type of weeds, were different for each seed lot. Machines and devices from the Danish manufacturers Kongskilde and Damas were used for seed cleaning. The equipment consisted of receiving basket with receiving belt, belt conveyors, bucket elevators, fine cleaning machine type Alfa - 4. The fine seed cleaning machine has an upper and a lower shaker shoe. For processing alfalfa in the upper row are round sieves with a diameter of 2.75 mm to 1.9 mm, and in the lower row with longitudinal openings of width: 1.3 mm to 0.5 mm. For cleaning red clover seeds in the upper row are sieves with round sieves in diameters: 2.75 mm; 2.5 mm; 2.25 mm; 2.1 mm; 1.9 mm and 1.9 mm. In the lower row are sieves with longitudinal openings of width: 1.3 mm; 1.2 mm; 1.1 mm; 0.6 mm; 0.5 mm and 0.5 mm. A magnetic separator from the German manufacturer Emeeka Gompper - type 4 was used to separate weeds with wrinkled and unsmooth seed coat and other impurities. In the magnetic separator mixer, the seeds are mixed with water and steel powder in a certain ratio.

The analysis of the samples of alfalfa and red clover seeds was done in the laboratory of the processing center using a magnifying glass with lighting. A precise electronic scale was used to measure the samples. The average sample for determination seed purity was 50 g from which the working sample for purity analysis was taken (5 g). The measurement of the weight of the processed seed was performed on an electronic scale with a measuring range of up to 300 kg. During the processing, the following parameters were determined and measured: quantity of pure seed (%), the seed of other species (%), inert matter (%), weed seed (%), and quantity of processed seed (kg). After processing, the yield of processing seed (%) and seed losses (%) on the processing equipment were calculated. The obtained results were processed by statistical analysis of variance (ANOVA), and the assessment of the significance of mean differences was tested by the Tukey test. The statistical program Minitab16.1.0 (statistics software package) was used for data processing.

RESULTS AND DISCUSSION

The purities of five different seed lots on natural alfalfa seed are shown in Table 1. The average purity of all five investigated seed lots was 76.0 %.

| Table 1. The average purity on the natural alfalfa seeds |
|----------|--------|--------|--------|--------|--------|
| Lot      | I      | II     | III    | IV     | V      |
| Seed structure | %      | %      | %      | %      | %      |
| Pure seed  | 76.0 a | 76.0 a | 76.0 a | 76.0 a | 76.0 a |
| Other species | 0      | 0      | 0      | 0      | 0      |
| Inert matter | 18.5 b | 24.0 a | 18.8 b | 24.0 a | 24.0 a |
| Weed      | 5.5 a  | 0      | 5.2 a  | 0      | 0      |
| Total     | 100    | 100    | 100    | 100    | 100    |

Tukey test statistical significance levels: p<0.05, differences in a row marked in small letters a, b, c... |

Inert matter ranged from 18.5 % (lot I) to 24.0 % (lot II, IV and V). Seeds of lot III had 18.8 % of inert matter, the difference in an inert matter between parties was statistically significant (p<0.05). The inert matter was in the form of damaged and sickly seeds, pods, harvest residues and soil. There were 5.5 % weeds in the natural seed of lot I, and 5.2 % in the seed of lot III. The content of quarantine weeds was not high and was 6 dodder seeds in a sample of 5 g in lot I, 2 seeds in lot III and 5 seeds in lot IV.

The average values of the initial seed purity of red clover seeds were 75.0 % (for seed lots IV and V), and 76.5 % (for seed lot I). The initial seed purity of seed lots II and III was 77.0 % (Table 2).

| Table 2. The average purity on the natural red clover seed |
|----------|--------|--------|--------|--------|--------|
| Lot      | I      | II     | III    | IV     | V      |
| Seed structure | %      | %      | %      | %      | %      |
| Pure seed  | 76.5 a | 77.0 a | 77.0 a | 75.0 a | 75.0 a |
| Other species | 0      | 0      | 0      | 0      | 0      |
| Inert matter | 15.3 b | 23.0 ab| 23.0 ab| 25.0 a | 25.0 a |
| Weed      | 8.2 a  | 0      | 0      | 0      | 0      |
| Total     | 100    | 100    | 100    | 100    | 100    |

Tukey test statistical significance levels: p<0.05, differences in a row marked in small letters a, b, c... |

Inert matter in the form of harvest residues (parts of stems, leaves, pods) and flowers accounted for 15.3 % of seeds of lot I. In seeds lots II and III there was inert matter in the form of harvest residues of 23 %. The seeds of lots IV and V had 25 % of inert matter in the form of crop residues and soil. In inert matter, there was a statistically significant difference (p<0.05) between lots IV, V and I (Table 2). In lot II was a total of 18 dodder seeds and two curly dock seeds. Apart from the 8 dodder seeds in the seed samples of seed lot I, there were greater plantain, bindweed and chamomile.

The average purity of the alfalfa seeds after the seed processing is shown in Table 3. After processing on a magnetic separator, the average purity of alfalfa seeds was high and amounted to 97.6 % (seed lots II and III). The average purity of processed seeds in seed lot V was 98.2 %, and in a seed lot IV was 98.4 %. The highest purity of 99.0 % was in the seeds of lot I. The content of other plant species, inert substances in the form of raw seeds and weeds was within the legally prescribed limits.
Inert matter in the form of sickly seeds and harvest residues ranged from 1.6 % to 2.4 %. In an average seed sample of 50 g, 4 seeds of the curly dock were found in the sample of seed lot II, which is the legally allowed amount of a maximum of 4 seeds in a sample of 50 g.

Table 3. The average purity of processed alfalfa seeds after processing on a magnetic separator

| Lot  | I       | II      | III     | IV      | V       |
|------|---------|---------|---------|---------|---------|
| Seed structure | %  | %  | %  | %  | %  |
| Pure seed | 99.0 a | 97.6 a | 97.6 a | 98.4 a | 98.2 a |
| Other species | 0   | 0   | 0   | 0   | 0   |
| Inert matter | 0   | 2.4 a | 2.4 a | 1.6 b | 1.8 ab |
| Weed | 1.0 | 0   | 0   | 0   | 0   |
| Total | 100 | 100 | 100 | 100 | 100 |

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

After passing the seeds through the fine cleaning machine, the seeds should be processed on a magnetic separator to remove weeds (Uhlarik et al., 2018). Seed samples for quality analysis are taken after seed processing on a magnetic machine (Đokić et al., 2019a). Seed processing is a very hard job where a large amount of energy is used to obtain seeds of appropriate quality (Orlobinski et al., 2017). The final seed purity of red clover, after processing on a magnetic separator is shown in Table 4. The purity of processed red clover seeds ranged from 96.6 % (seed lot III) to 99.0 % (seed lots IV and V). The final seed purity for seed lot I was 98.4 %, and for seed lot II was 98.8 %. The content of other plant species, inert matters in the form of sickly seeds and weeds was within the legally prescribed limits. In an average seed sample (50 g) 3 seeds of the curly dock were found in seed lot III, which is allowed by law. In seed lots I and II, a detailed analysis of seed samples found 0.2 % of seeds of other species, which is significantly less than the legally allowed amount of seeds of other species (2 %).

Table 4. The average seed purity on processed red clover seeds after processing on a magnetic separator

| Lot  | I       | II      | III     | IV      | V       |
|------|---------|---------|---------|---------|---------|
| Seed structure | %  | %  | %  | %  | %  |
| Pure seed | 98.4 a | 98.8 a | 96.6 a | 99.0 a | 99.0 a |
| Other species | 0.2 | 0   | 0   | 0   | 0   |
| Inert matter | 1.0 ab | 0.8 b | 1.4 a | 1.0 ab | 1.0 ab |
| Weed | 0.4 | 0.2 | 2.0 | 0 | 0 |
| Total | 100 | 100 | 100 | 100 | 100 |

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

The quantities of alfalfa seed at the beginning, as well as the amount of processed seed at the end of the processing, are shown in Table 5. The processing output and losses on processing machines are also calculated and expressed as a percentage. The highest seed processing output was in lot IV seeds and amounted to 72.2 %, with the lowest losses on processing machines of 5.0 %. In the examined alfalfa seeds, the lowest seed processing output of 57.7 % was in seed lot II. This seed also had the largest losses on processing machines, amounting to 23.9 %.

The quantities of natural red clover seed at the beginning and the quantities of processed seeds at the end of the processing are shown in Table 6. The quantities of natural and processed seeds are expressed in kg. The table also shows seed processing output and losses on processing machines expressed in %. The highest seed processing output was in seed lot III (71.3 %). The seeds of this seed lot also had the lowest losses on processing machines (7.4 %). Seed lot II had a very similar seed processing output of 71.0 % and losses of 7.8 %.

Table 5. Amounts of processed seeds, processing output and losses of alfalfa seeds on the processing machines

| Lot  | I       | II      | III     | IV      | V       | F test |
|------|---------|---------|---------|---------|---------|--------|
| Natural seed (kg) | 990.0 b | 2334.0 a | 2250.0 a | 769.0 b | 2247.0 a | **     |
| Processed seed (kg) | 690.0 c | 1545.0 a | 1300.0 b | 550.0 c | 1516.0 a | **     |
| Processing output (%) | 69.7 ab | 66.2 ab | 57.7 b | 72.2 a | 67.5 ab | **     |
| Losses (%) | 8.3 c | 12.9 b | 23.9 a | 5.0 d | 11.2 b | **     |

F test, statistical significance levels: *p<0.05, **p<0.01, ***p<0.001, ns – not significant (p ≥ 0.05)
Tukey test statistical significance levels: p<0.05, differences in a row marked in small letters a, b, c,...

The seed lot IV had the lowest processing output (48.8 %), and the largest losses on processing machines which amounted to 35.8 %.

Table 6. Amounts of processed seeds, processing output and losses of red clover seeds on the processing machines

| Lot  | I       | II      | III     | IV      | V       | F test |
|------|---------|---------|---------|---------|---------|--------|
| Natural seed (kg) | 184.0 d | 1072.0 a | 624.0 b | 378.0 c | 1199.0 a | ***    |
| Processed seed (kg) | 108.0 c | 761.0 a | 445.0 b | 182.0 c | 741.0 a | **     |
| Processing output (%) | 58.7 b | 71.0 a | 71.3 a | 48.8 c | 61.8 b | *      |
| Losses (%) | 23.3 a | 7.8 c | 7.4 c | 35.8 a | 17.6 b | ***    |

F test, statistical significance levels: *p<0.05, **p<0.01, ***p<0.001, ns – not significant (p ≥ 0.05)
Tukey test statistical significance levels: p<0.05, differences in a row marked in small letters a, b, c,...

For the alfalfa seeds, losses ranged from a minimum of 5.0 % to 23.9 %. In the red clover seeds, these losses were even higher and ranged from 7.4 % to 35.8 %. Such a large variation in losses can be the result of several factors: seed purity and weed content, especially quarantine weeds, can significantly affect the loss and amount of seed obtained. In our earlier investigations, during the seed processing of alfalfa seeds (initial purity from 70 % to 86 %), seed losses ranged from 14.43 % to 15.56 %. In the case of red clover seeds (initial purity from 74 % to 80 %), seed losses ranged from at least 11.3 % to 18.56 % (Đokić et al., 2020). If there are quarantine weeds in the seed samples (especially dodder seeds), each repeated passing of the seeds through the processing machines leads to the seed losses (Đokić and Stanisavljević, 2012). Also, the adjustment of the machines during the seed processing and the selection of appropriate sieves on the fine cleaning machine, as well as the ratio of water and metal powder on the magnetic machine, can significantly affect the number of losses. Any defect in the cleaning process can lead to significant seed losses (Erić et al., 1996; Uhlarik et al., 2018). Proper adjustment of machines, as well as proper selection of machines for seed processing, could reduce losses and increase the amount of obtained quality seed (Kozlov V., 2013).

CONCLUSION

The purity of natural alfalfa seeds was 76.0 % in all five seed lots. The natural alfalfa seed contained inert matters and weeds in different percentages in different seed lots and inert matters ranged from 18.5 % to 24.0 %. The maximum of weed seed was 5.5 %. Natural red clover seeds of different seed lots had seed purity from 75.0 % to 77.0 %. Inert matters in the form of harvest residues ranged from 15.3 % - 25.0 %. By increasing the content of weeds and impurities in natural seeds, the technological processes are longer, energy consumption is...
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