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SPECIFICS OF SOYBEAN SEED PRODUCTION AND PROCESSING IN 2019

SPECIFIČNOSTI PROIZVODNJE I DORADE SEMENA SOJE U 2019. GODINI

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ABSTRACT

The soybean harvest in 2019 began at the end of August. The quality of the natural seed was very high. The moisture content of the harvested seeds ranged from 7.1 % to 14.1 %. Thanks to this humidity, there was no need to dry the seeds, which is very important given the fact that drying soybeans can reduce the quality. Seed germination ranged between 82 % and 96 %. It should be noted that 97 % of seeds were harvested with germination greater than 85 % while about 65 % of seeds had germination above 90 %. The weight of 1000 grains averaged about 160 g. Soybean seed processing started on time and without major problems. The purity of the processed seed was on average 99.4 %. Of the total amount of processed seeds, about 72 % of seeds had germination greater than 85 %. The achieved seed quality was better compared to the one in 2018.

Keywords: *soybean, production, harvest, seed reception, processing.*

REZIME

Iako su proizvodnju soje u 2019. godini pratili brojni problemi, na kraju možemo da kažemo da je bila uspešna kako po zasejanim površinama tako i po ostvarenom prinosu. Žetva soje započela je krajem avgusta. Prijem semena u doradnim centrima obavljen je bez većih problema zahvaljujući dobro pripremljenoj opremi i dobroj organizaciji prijema semena. Kvalitet naturalnog semena bio je veoma dobar sa zanemarljivo malim prisustvom zelenih i nedozrelih zrna. Vlažnost požnjevenog semena bila je u rasponu od 7,1% do 14,1% dok je oko 65% semena zaprimljeno sa vlažnošću iznad 10%. Zahvaljujući ovakvoj vlažnosti, nije bilo potrebe za sušenjem semena što je jako važno s obzirom na činjenicu da se sušenjem soje kvalitet može smanjiti. Klijavost semena, kao najvažniji parametar kvaliteta, bila je u rasponu između 82% i 96%. Treba istaći da je 97% semena požnjeveno sa klijavošću većom od 85% dok je oko 65% semena imalo klijavost iznad 90%. Masa 1000 zrna u proseku je iznosila oko 160 g. Na osnovu zaprimljenih količina semena u doradnim centrima može se reći da će količina semena nakon dorade biti dovoljna za setvu soje u 2020. godini. Dorada semena soje počela je na vreme i bez većih problema. Ostvarena čistoća dorađenog semena bila je u proseku 99,4%. Od ukupne količine dorađenog semena oko 72% semena imalo je klijavost veću od 85%, dok je oko 50% semena imalo klijavost iznad 90%. Ostvareni kvalitet semena bio je bolji u odnosu na 2018. godinu.

Ključne reči: *soja, proizvodnja, žetva, prijem, dorada.*

INTRODUCTION

According to the announcement of the Republic Bureau of Statistics of Serbia, the sown areas under soybeans in 2019 increased by 16.7 % compared to 2018 and amount to 229,372 ha *(www.stat.gov.rs).* According to the estimates of the Business Community for Industrial Plants, soybeans were sown on an area of about 220,000 hectares in 2019, with an average yield at the state level of 2,900 to 3,000 kg/ha *(Đukić et al., 2020),* which is by about 500 kg more when compared to the long-term average soybean yield in the Republic of Serbia. If we take into account the fact that the areas sown under soybeans in 2019 were also increased, then it can be said that soybean production in the previous year was very successful. Based on the presented results (Figure 1), a constant trend of increasing the area sown under soybeans in the Republic of Serbia in the last few years can be observed. Although soybean production is strongly influenced by climatic and other production conditions, thanks to a good assortment and increased investments in production, it can be said that the average yield, and thus the total soybean production, is growing from year to year.

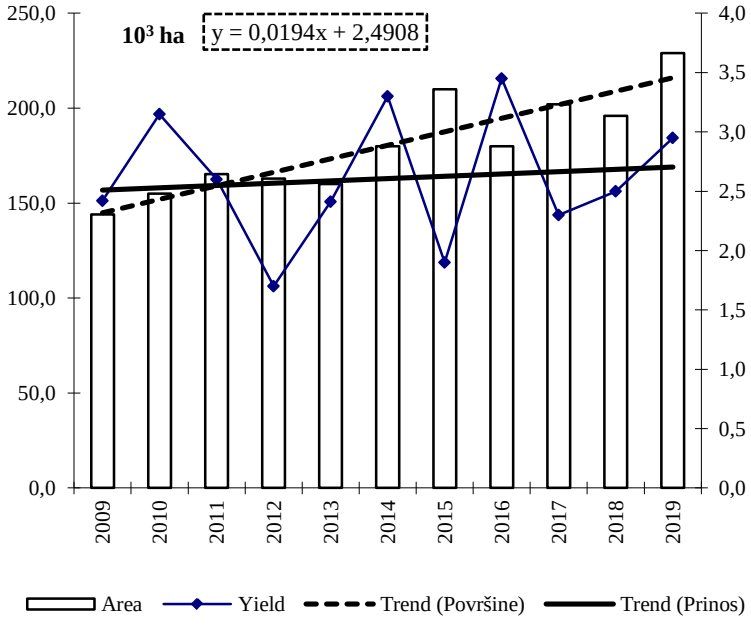

Fig. 1: Areas and yields of soybeans in the Republic of Serbia in the period 2009-2019

Production of soybean in 2019

In most production regions during 2019, the amount of precipitation, as well as the average monthly temperatures increased compared to the multi-year average. However, due to the very cold and rainy spring as well as the wet soil, sowing was delayed, while the period of germination and germination in the sown areas was significantly extended. In the first and second decade of May, the average daily temperatures were significantly lower compared to the multi-year average in all observed regions (by about 3°C), while the amount of precipitation was higher *(Đukić et al., 2020).* Such unfavourable conditions led to poor seed germination and thus to thinned assemblies, which is why producers had to sift a certain number of plots. After this cold period, much more favourable conditions occurred, which encouraged intensive growth and development of soybean crops. However, in July, a pronounced lack of precipitation prevailed in most production regions, especially in the second and third decades (lack compared to multi-year values by more than 30 mm). In the last decade of July and during August, the measured temperature values were 2-3°C above the multi-year average. As a consequence of stressful conditions during the seed watering period, the top pods on soybean plants were insufficiently watered, which led to a reduction in yield. The soybean harvest began in late August.

MATERIAL

Harvested soybean seeds were brought by truck and tractor conveyors to the processing centres, where they were measured on a weighbridge. After the measurement, it was sampled using appropriate probes according to the established seed sampling procedure for each vehicle. Then, the formation of samples was started, which were submitted to the authorized laboratory for analysis after marking. An analysis of the submitted samples was performed in the laboratory according to the rulebook on seed testing *(Official Gazette of the SFRY No. 47/87)*. Seed moisture, 1000 grain weight, germination energy, seed germination, the content of atypical germinate, inert substances, as well as the content of broken grain, were examined. Processed soybean seeds were sampled and tested by varieties and batches by the laboratory for testing the quality of seeds at the Institute of Field and Vegetable Crops from Novi Sad.

RESULTS AND DISCUSSION

Receiving, storage and processing of soybean seeds

Seed reception in processing centres was performed without major problems thanks to well-prepared equipment by the processor together with well-organized seed reception. The available storage capacities in the processing centres for receiving soybean seeds were sufficient to accept and store the planned amount of produced seeds without major problems. The quality of natural seeds was very good with an insignificantly small presence of "green" and immature grains. However, depending on the producer, smaller quantities of natural seeds had a certain presence of immature grains at the beginning of the harvest, which is why it was necessary to process the seeds on a rough purifier before storing them in silo cells. This measure is very important because storing soybean seeds (along with impurities) without prior purification would be very risky. The rough purifier has the role of extracting large impurities from the seeds, such as parts of harvest residues, unfinished pods (usually with physiologically immature grain), lumps of earth, as well as very small impurities and dust. The moisture content of harvested soybean seeds ranged from 7.1 % to 14.1 %. Most of the seeds of about 55 % were received with a moisture content above 10 %, which is very important considering that the moisture content in the grain is one of the important internal factors that affect the mechanical properties of the seeds. Furthermore, thanks to this humidity, there was no need to dry the seeds, which is very important given the fact that in addition to the increased cost of drying, the quality of the seeds would be significantly reduced. Numerous papers can be found in the literature that indicate that soybean seeds that have a low moisture content are exposed to mechanical damage. *Hoeft et al., (2000)* state that the soybean harvest should be completed before the seed moisture falls below 12 % due to cracking and damage to the seedling. It should be noted that about 45 % of soybean seeds in processing centres were received with humidity levels lower than 10 %. Therefore, it was necessary to receive and process soybeans carefully in order to minimize the risk of mechanical damage to the seeds. Germination of harvested seeds, as the most important quality parameter, ranged between 82 % and 96 %. It should be noted that as much as 97 % of seeds were harvested with germination greater than 85 % while about 61 % of seeds had germination above 90 %, which represents a very high quality of natural seeds. The weight of 1000 grains averaged about 160 g. It should be noted that this year the soybean grain was smaller compared to the previous year, so larger amounts of waste can be expected during seed processing. The content of inert substances in natural seeds averaged about 1.8 % and ranged from 0.1 % to as much as 9.3 %. The average content of broken grain in natural seeds was about 1.9 % and ranged from 0.1 % to extremely high 16.3 %. Based on the quantities of seeds received in the processing centres, it can be said that the number of seeds after processing will be sufficient for sowing soybeans in 2020. If we compare the average quality of natural soybean seeds produced in 2019. with the natural quality of seeds produced in the previous year, we can see that seed moisture, germination energy, seed germination and the content of atypical germinate have approximately the same values (Table 1). Only the values of the mass of 1000 grains, the content of broken grain and to some extent the content of inert substances are different.

Table 1. The average quality of natural soybean seeds in 2018 and 2019

Year	Humid. (%)	Inert substan. (%)	Broken seed (%)	Mass of 1000 grains (%)	Germination energy (%)	Seed germination (%)	Atypical germination (%)
2018	10.00	2.07	3.79	175.83	84	89	5
2019	10.13	1.77	1.87	159.87	85	90	5

In other words, it could be said that the quality of seeds in the observed two years was very uniform. However, unlike 2019, in which as many as 97 % of seeds had germination higher than 85 %, in 2018 this share of seeds was lower and amounted to 85 % (Table 2). Based on the results from Table 2, it can be

Table 2. The share of natural soybean seeds whose humidity is lower than 10 % and the share of seeds with germination above 85 % in 2018 and 2019

Year	Humidity < 10 %	Seed germination < 75 %	Seed germination > 85 %
2018	49 %	4.5 %	85 %
2019	45 %	0 %	97 %

said that the quality of natural seeds produced in 2019 was better.

Most of the processors this year started processing soybean seeds on time so the seeds were not stored in silo cells for a long time, which is very important. Namely, storing soybean seeds in warehouses for a longer period of time is not recommended because it can lead to reduced germination. Therefore, it was necessary to organize the processing of seeds as soon as possible so that the storage period of soybean seeds would be as short as possible. In the beginning, the most important thing was to provide the documentation necessary for the issuance of labels. It should be noted that the collection of the Certificate on the recognition of soybean seed crops this year was not delayed. In a short period of time, the agricultural expert services and the Ministry of Agriculture of the Republic of Serbia prepared the mentioned documentation so that the organization and processing of soybean seeds could be started in a timely manner. Since the quality of natural soybean seeds was very good, there were no major problems during seed processing, which is why this work was completed on time. Thanks to the favourable humidity of natural seeds, mechanical damage during manipulation and processing of seeds was minimal in most processors. The moisture content in the grain affects the physical properties of the seed, so the grain with a moisture content of 8 to 10 % is significantly more sensitive to shocks than a grain whose moisture content is 11 to 15 % *(Crnobarac et al., 2008).* Regardless of the favourable moisture content in the grain, it was necessary to equip the seed processing line with a sufficient number of seed drop dampers, since when handling soybean seeds from the hopper to the packaging device, there is a different degree of damage to the grain. However, some processors had certain organizational problems, which delayed the start of seed processing. Furthermore, they did not prepare their equipment to a sufficient extent, which all together influenced the fact that soybean seeds did not have the required quality after processing. The stated soybean seed which has poor quality will not be delivered to the market as seed material. The achieved purity of processed seeds was on average 99.4 %, which is a very good result considering that the legal minimum for the purity of soybean seeds is 96 % *(Official Gazette of SFRY No. 47/87. Rule on the quality of agricultural plant seeds. 1987)*, all finishing centres ranged from 96.8 % to 99.9 %. Such a wide range in seed purity was created as a consequence of different equipment of processing centres, applied seed processing technology, quality of natural seed as well as genotype. It has already been said that the production conditions did not affect the sowing and maturation of soybean seeds, which affected the weight of a thousand seeds to be lower than the usual values. However, in addition to the production conditions themselves, this parameter of seed quality largely depends on the genotype *(Kostić, 2016)*. It should be noted that the amount of waste generated during seed processing this year was pronounced, because natural soybean seeds were quite small and insufficiently watered, which is unfavourable since seed size can affect seed germination and initial plant growth *(Kostić, 2013)*. Yields for some varieties were very low, about 80 % and even lower, which makes the production in 2019 stand out from previous years. Of the total amount of processed seeds, about 72 % of seeds had germination greater than 85 %, while about 50 % of seeds had germination above 90 %. If we take into account that the legal minimum for soybean germination is 75 % *(Official Gazette of SFRY No. 47/87. Rule on the quality of agricultural plant seeds. 1987)*, then we can say that the achieved quality of soybean seeds in 2019 is very good, which confirms the fact that favourable conditions for seed production in the field and applied geotechnics together with quality processing and storage of seeds greatly contribute to the good quality of soybean seeds *(Tatić, 2007)*. However, there were processors in which the seeds of individual batches had a germination rate of less than 75 %, which is a consequence of mechanical damage to the seeds during manipulation and processing. These batches of seeds were denatured and as such, with all the accompanying documentation, were delivered to the processors as mercantile grain. If we compare the average quality of processed soybean seeds produced in 2019 with the quality of processed soybeans from 2018, we can see that the measured values of moisture and seed purity are approximately the same (Table 3.) while germination energy, seed germination and atypical germinate content in 2019 were significantly better.

Unlike in 2018, when as much as 25 % of processed seeds did not have the required quality, in 2019 there were only 6 % of such seeds. It is reliably known that the soybean grain is very sensitive to impact because the embryo is located just below the thin seed coat and can be easily damaged by mechanical action. Therefore, it is necessary for the processors to finish the soybean seeds very carefully and prepare the equipment for this important job, as already mentioned. The increase in soybean seed breakage during handling and transport depends on the impact force acting on each individual grain as well as on the seed moisture. The amount of crushed and broken seeds increases with each operation of manipulation and transport. It is very important to adjust the dynamics of processing so that the newly arrived quantities of seeds in the hopper are poured on the previously poured batch of seeds. In this way, the impact of the grain on the bottom and walls of the hopper is avoided, and thus the mechanical damage to the seed is reduced. *Shreekant et al., (2002)* found that soybean seed germination decreases by an average of 10 % to 31 % if the seed falls from a height of 1 to 2 meters on a concrete floor, while seed germination decreases by 7.5 % to 22 % if the seed falls from the same height on the galvanized metal floor. They also confirmed that seeds with a moisture content of 12 % suffer less damage compared to seeds whose humidity is lower than 10 %. In addition to the moisture content in the seed, *Kostić et al., (2012)* point out that the genotype also has an impact on the resistance of the seed to mechanical damage to the seed. *Hurburgh, (1995)* states that seeds with a lower humidity of 10% become very brittle and easily break in half during harvesting and manipulation, and even the processing of such seed soybeans reduces the germination of seeds. This indicates that during the harvest, reception, storage and processing of soybean seeds, it is necessary to respect and apply the correct technology, which requires great expertise, discipline and special care when handling seeds.

Table 3. The average quality of processed soybean seeds in 2018 and 2019

Year	Humidity (%)	Seed purity (%)	Mass of 1000 grains (%)	Energy germination (%)	Seed germination (%)	Atypical germinate (%)	Seed germination rate < 75 % (%)
2018	10.0	99.0	168.4	74	79	9	25
2019	10.2	99.4	162.6	80	87	6	6

CONCLUSION

The production of soybean seeds in 2019 was accompanied by favourable weather conditions. Thanks to that, quality assortment and adequate investments by producers, above-average grain yields were achieved in both mercantile and seed production of this important plant species. The quality of natural seed in seed production was high, with minimal presence of immature grains. Seed reception was done in a timely manner and without major problems, thanks to well-prepared equipment and organization of seed reception. Most of the seeds of about 65 % were received with a moisture content above 10 %, which is very important considering that the moisture content in the grain is one of the important internal factors that affect the mechanical damage to the seeds. Therefore, it is very important to complete the soybean harvest before the seed moisture drops below 12 %.

Moreover, it is necessary to manipulate the seed in the processing centre as little as possible, in order to reduce the risk of mechanical damage to the grain. Seed germination ranged between 82 % and 96 %, while 97 % of seeds were harvested with germination greater than 85 %. Furthermore, about 65 % of seeds had germination above 90 %, which is a very good quality of natural seeds. The weight of 1000 grains averaged about 160 g. It should be noted that agroecological conditions during seed production in the field have a great influence on seed quality. In addition to agroecological conditions, seed quality also depends on the elasticity of soybeans, which can be a varietal characteristic. Seed processing was done mostly on time, but some processors completed this work with a certain delay. The achieved purity of processed seeds was on average 99.4 %. Of the total amount of processed seed, about 72 % of seeds had germination greater than 85 %, while about 50 % of seeds had germination above 90 %. Therefore, it can be said that in 2020, producers will have very good quality seeds at their disposal. However, 6 % of the processed seeds did not have the required minimum germination of 75 %, which is a great damage that occurred as a result of mechanical damage to the seeds during manipulation and processing of seeds. In the end, it can be concluded that the quality of both natural and processed seeds in 2019 was better than the achieved quality of seeds produced in 2018.

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