ТЕХНОЛОГИЯ И ОБОРУДОВАНИЕ МЕХАНИЧЕСКОЙ И ФИЗИКО-ТЕХНИЧЕСКОЙ ОБРАБОТКИ / TECHNOLOGY AND EQUIPMENT FOR MECHANICAL AND PHYSICAL-TECHNICAL PROCESSING

DOI: https://doi.org/10.23670/IRJ.2023.138.27

STUDY OF SOYA GRAIN DAMAGE DURING HARVESTING AND PART-TIME WORK

Data paper

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Abstract

The existing technology for producing soybean seeds does not provide them with high quality indicators and, accordingly, the full realization of the potential possibilities of soybean varieties in terms of yield. A new technology for obtaining high-quality conditioned seeds is proposed, with a separate fraction in two-phase threshing combines, which are already released during harvesting. The seed fraction obtained from the combine without subsequent post-harvest part-time processing meets the requirements for the sowing properties of soybean seeds at the level of the first class and can be used in sowing. Such a rather important task, the implementation simultaneously in one technological scheme of soybean harvesting with the production of seeds has not been implemented today in any Russian or international engineering company. To obtain high-quality soybean seeds in a two-phase threshing combine during harvesting, technological and design solutions have been developed that allow dividing threshed grain in terms of quality into two fractions – seed for use in sowing without part-time production and commercial. Separately, collect them in a two-section bunker of the combine. Separating the rolled board into two parts and preventing mixing of the sieved grain, which is soaked with the first and browned with the second threshing drums in rigid modes, more than 60% of the quality soybean seeds of the first fraction extracted during threshing and separation from the first threshing drum are separately obtained in a separate hopper of the combine.

Keywords: soybeans, combine harvester, threshing, harvesting, part-time work, crushing, conditioned seeds, germination, yield.

ИССЛЕДОВАНИЕ ПОВРЕЖДАЕМОСТИ ЗЕРНА СОИ ПРИ УБОРКЕ И ПОДРАБОТКЕ

Статья с данными

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Аннотация

Существующая технология получения семян сои не обеспечивает им высоких качественных показателей и, соответственно, полную реализацию потенциальных возможностей сортов сои по урожайности. Предложена новая технология получения качественных кондиционных семян, отдельной фракцией в комбайнах двухфазного обмолота, выделяемых уже в процессе уборки урожая. Получаемая от комбайна семенная фракция без последующей послеуборочной подработки соответствует по требованиям к посевным качествам семян сои на уровне первого класса и может использоваться на посеве. Такая достаточно важная задача, реализации одновременно в одной технологической схеме уборки сои с получением семян не реализована на сегодняшний день ни в одной российской или международной машиностроительной компании. Для получения качественных семян сои в комбайне двухфазного обмолота в процессе уборки урожая, разработаны технологические и конструкторские решения, позволяющие разделять обмолоченное зерно по качеству на две фракции – семенную для использования на посеве без подработки и товарную. Отдельно собирать их в двухсекционном бункере комбайна. Разделяя скатную доску на две части и предотвращая смешивание просепарированного зерна, вымолоченного первым и домолоченного вторым молотильным барабанами на жестких режимах, раздельно получают в отдельном бункере комбайна свыше 60% качественных семян сои первой фракции, выделяемой при обмолоте и сепарации от первого молотильного барабана.

Ключевые слова: соя, комбайн, обмолот, уборка, подработка, дробление, кондиционные семена, всхожесть, урожайность.

Fields title

The use of innovative soybean cultivation technologies providing for a set of measures to obtain high yields is gradually being introduced in agricultural production. So, in 2022, the Amur Region produced 1 million 600 thousand tons. of soybeans, which suggests that the use of innovative soybean cultivation technologies in full ensures a yield of at least 2.0 t/ha.

Seeds and their quality are the most important factors in increasing crop yields, including soybeans. Only with high biological and qualitative indicators of seeds, the potential capabilities of varieties are fully used [1], [2], [3], [4].

In increasing soybean production, an important role is played by reducing the loss of soybean grain from crushing, especially when harvesting the grown crop. The working elements of the combine perform unequal force action on the grain in the process of destruction of its connection with the flaps of beans, in the extraction and transportation of grain and damage it (Table 1). The strength of soybean grains under mechanical influences is largely predetermined by its humidity. When soybean

grains are processed above and below the conditioned humidity, their strength decreases, which leads to an increase in grain crushing and microdamage [5], [6].

Table 1 - Damage to soybean grain by working tools of the combine

DOI: https://doi.org/10.23670/IRJ.2023.138.27.1

Rabochiye organs	Grain damage,%	
	To soldered grain	Accruing damages
Inclined kamera	0,53	0,53
First baraban	5,56	6,09
Promezhutochnyy beater	0,61	6,7
Second baraban	2,89	9,59
Otstoynyy beater	0,49	10,08
Solomotryas	0,07	10,15
Ochistka	0,24	10,39
Grain auger	2,19	12,58
Grain elevator	1,85	14,43
Spike auger	1,23	15,66
Grate elevator	1,09	16,75
Small grain auger	0,85	17,6
Total	-	17,6

It is recommended to use two-phase threshing combines with two-flow cleaning during seed harvesting. Combine harvesters with two drum threshing device make it possible to reduce grain damage due to reduction of rotation speed during threshing with the first drum. But this threshed grain is not separately released in the combine and is mixed with the grain mined by the second drum in more stringent modes, therefore, during harvesting, elite and reproducible grain is obtained, and then, during part-time processing, seeds with a high content of crushing and microdamage [7], [8], [9], [10].

Harvested soybean grains are worked on grain-cleaning complex at positive temperature and optimal humidity. When harvesting and part-time work of original and elite seeds, more advanced expensive equipment with minimal load on the combine is used and, accordingly, compliance with the specified modes and terms of operation of the combine harvesting and post-harvest part-time work is ensured.

Reproduction soybean seeds for commercial crops are produced in 23 seed farms of the region on large areas of cultivation and a high harvesting load on the combine. Reproduction soybean seeds should have a variety purity of at least 98%, seed purity – 95%, the content of seeds of other plants – 25 pcs ./kg (including weeds 15 pcs./kg), germination 80%, humidity 14%. According to the results of analysis of various batches of soybean seeds, the main indicators for which soybean seeds turned out to be substandard are the waste of the main crop, which includes crushed grain and reduced germination – microdamaged grain, as well as irregularly shaped grain (frost and fished by pests).

When soybean is worked for seeds on production lines of seed farms equipped with serial grain cleaning machines with various working bodies, numerous transporting machines, grain pipelines, reproduction seeds are additionally damaged. After working, in reproduction seeds, the crushing content increases to 6.34% and microdamage to 4.97%. And the total amount of mechanical damage obtained during cleaning and part-time work due to non-compliance of soybean strength with force impacts is more than 20%.

To improve the quality of soybean grain produced in harvesters during harvesting, commercial grain is sorted. The resulting crushed grain wastes are sold for processing under the category "oilseed impurity" [11], [12]. Or commercial grain is sold, without part-time processing, with a decrease in the reference weight of the grain by the amount of crushing. And for sowing purposes, part of the seed is used, which has high biological properties, which can not always be obtained and especially in adverse weather years.

According to statistics, it was revealed that on average over 40 years, about 20... 25% of soybean fields are sown with substandard seeds.

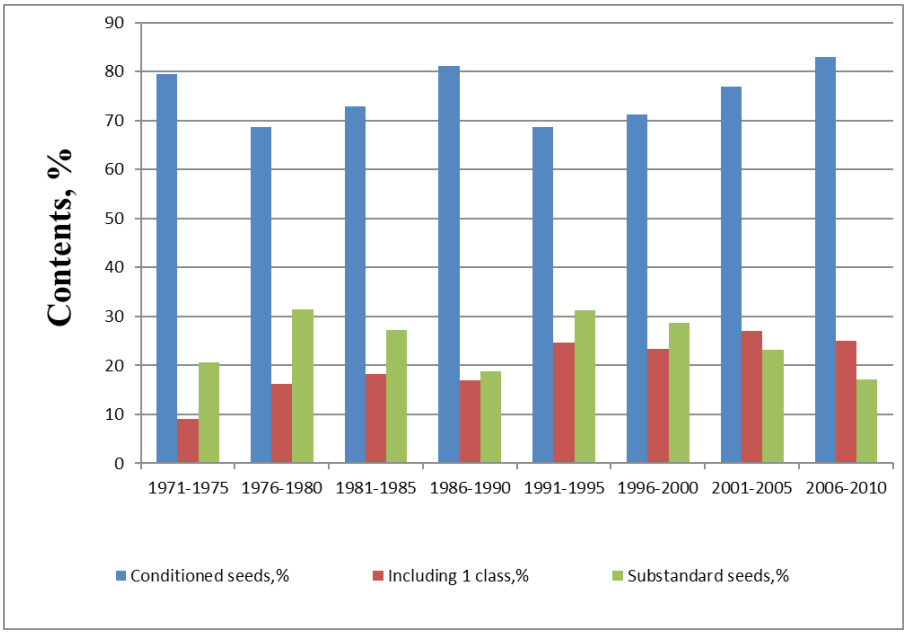

Figure 1 - Quality of soybean seeds sown in the farms of the Amur oblast
DOI: https://doi.org/10.23670/IRJ.2023.138.27.2

When cultivating soybeans, only seeds of the first and second classes are allowed to sow, and as an exception (in the absence of the best seeds) it is allowed to use third-class seeds on general crops, but despite this, 18 to 25% of substandard seeds with germination below 75% are sown in the region. Studies have proven that the higher the quality of soybean seeds, the higher the harvest. So, in the Tambov region, when sowing 93% with conditioned seeds, the soybean yield was on average 2.8 c/ha in three years, compared to the Konstantinovsky district, which has 86.9% of conditioned seeds and 3.2 c/ha higher than the soybean yield of the Ivanovo region, which has 69.7% of conditioned seeds.

To obtain seeds directly in a two-phase threshing combine, it is necessary to improve the technological process of operation of the threshing and separation device, the purification system, separate collection of seeds and the commercial fraction.

The purpose of the work is to develop a technology for harvesting soybeans for seeds during its harvesting by a two-phase threshing combine, based on the development of adaptation devices with minimal impact during threshing by the first threshing drum, separation and cleaning of the obtained fraction on the first half of the combine sieve mill and its collection in a two-section bunker

Methods

To determine the losses from damage to soybean grain during harvesting and to justify a more effective method of obtaining high-quality seeds in seed farms during harvesting directly from domestic and imported harvesters, general samples of bunker and seed grain prepared for sowing weighing up to 2 kg were taken. Then, 4 samples of 100 g were separated from the total samples by the divider, which were sorted into fractions, each fraction was weighed and analyzed by purity, size and types of mechanical and biological damage to soybean seeds during harvesting and part-time work. Further, in laboratory and field conditions, experiments were carried out, the purpose of which was to obtain experimental data on the effect of the type of damage on the sowing and yield properties of soybean seeds. The content of crushing and micro damage to soybean seeds was determined according to GOST R 52325-2005 "Seeds of agricultural plants. Varietal and inoculum qualities. General Technical Specifications. "Micro damages were determined according to the method of I.M. Prisyazhnaya et al. (2018); Field studies were carried out according to B.A. Dospekhov (2012). The Yenisei-1200 combine was converted to create a corresponding operating mode of the first threshing drum, separate cleaning of fine heap threshed with the first and second drums and separate collection of seeds in the two-section bunker of the combine and studies were carried out.

In a two-phase threshing combine, when the circumferential speed of the impact of the first drum is reduced to 8.1 m/s and the second to 16.1 m/s, or when the frequency of rotation of the first drum 280 and the second 560 min-1 is obtained, high-quality threshing of soybeans with minimal crushing is provided.

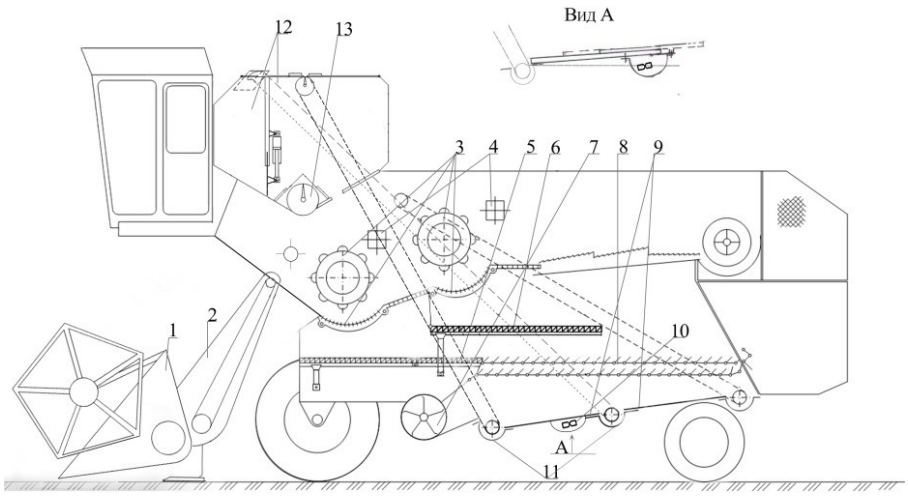

Figure 2 - Device of combine for production of seed fraktsii:
1 - harvester reaper; *2* - tilting chamber; *3* - the first and the second threshing drums with a sub-drum; *4* - beaters; *5* - main quagmire board; *6* - additional quagmire board; *7* - fan; *8* - upper cleaning screen; *9* shows the first and second pitched boards; *10* - additional fan; *11* - grain screws of seed and commercial fraction; *12* - seed and commercial fraction hopper; *13* - discharge screw

DOI: https://doi.org/10.23670/IRJ.2023.138.27.3

The mode of operation of first threshing drum is set by means of rearrangement of larger pulley from shaft of main counter-drive to shaft of first threshing drum. The use of two replaceable pulleys, the smaller (200 mm) of which provides 280 min-1, and the larger (300 mm) - 380 at rated engine speeds. The mode of the second threshing drum (540-660) is set by rearranging the variator-adjustable serial pulleys on the shafts of the main counter-drive and drum.

Results

Obtaining a high-quality seed fraction in a two-phase threshing combine is primarily associated with improving the design of the LCS. Creating a gentle mode of threshing the first drum with a circumferential speed of beatings up to 8.1 m/s (and less power impact), allows significantly reducing the crushing and microdamage of threshed grain during threshing and obtaining seeds with high germination.

In a two-phase threshing combine, when the circumferential speed of the impact of the first drum is reduced to 8.1 m/s and the second to 16.1 m/s, or when obtaining the rotation speed of the first drum 280 and the second 540 min-1,clearances at inlet/outlet of the first and second drums – 24/12 and 18/9 mm, high-quality threshing of soybeans with minimal crushing is provided.

On average, over two years of research during the harvesting of soybeans of the September variety at the Federal State Budgetary Institution of the Federal Research Center of the All-Russian Research Institute of Soybeans, the modernized Yenisei-1200 combine separately received high-quality seeds of the first fraction and commercial grain of the second fraction. The control (Table 2) used soybean seeds obtained according to the traditional harvesting technology by the Vector-410 combine and post-harvest part-time processing at the Petkus-Giant grain cleaning machine K-53. Separating the fine soy heap from the first threshing drum and cleaning the weed impurity in the first half of the sieve, we obtain a clean, higher quality first seed fraction.

Separating the rolled board into two parts and preventing mixing of the sieved grain, which is soaked with the first and browned with the second threshing drums in more rigid modes, separately by fractions is obtained directly in a separate combine hopper over 60% of the seeds of the first fraction of the total soybean harvest. The experimental combine with two-phase threshing and two-stream grain cleaning during soybean harvesting differs slightly in terms of operational indicators from the serial one, the obtained data indicate that the experimental combine has a lower process maintenance factor of K1 by 0.01 0.02, a process reliability factor of K2 by 0.01 0.03 and a shift time utilization factor of 0.05 0.06. But it has 0.01 0.03 higher operating time utilization factor Kak. The specific fuel consumption is 11.9 l/ha. During the harvesting period, a pilot combine harvester threshed 204.1 tons of soybeans from them, respectively, 120.5 tons of seed fraction.

Table 2 - Quality indicators of the separately isolated first fraction of soybean seeds in the Yenisei 1200 combine during harvesting urozhaya

DOI: https://doi.org/10.23670/IRJ.2023.138.27.4

Order No.	Pokazateli	I fraction (seed)	Kontrol (seed for sowing)

1	Yield of seeds,% of total urozhaya	61,4,±2.39	70,0
2	Laboratornaya germination,%	94±3,96	86
2	Polevaya germination, %	90,8±4,14	70,0
3	Biological yield, t/ga	3,96±0,38	3,6
4	Purity of seeds,%	99,8±0.036	98,4
5	Seed crushing,%	3,4±0.086	6,3
6	Microdamage,%	0,9±0,021	4,9
7	Massa 1000 seeds, g	174,1±10.23	153,2

The most ripened biologically complete soybean seeds of the first fraction have increased mass of 1000 seeds, high sowing properties and increased productivity, lower value of crushing and microdamage. Using the first soaked and refined grain fraction per seed obtained in a separate hopper of a modernized combine eliminates additional seed part-time work, significantly reduces seed damage and increases biological yield by 10%.

Conclusion

Developed technology of seeds production during harvest in two-phase threshing combines in comparison with traditional technology reduces losses of quality soybean grain from crushing, their use in sowing reduces indirect losses. The creation of a separate series of combiners for harvesting soybeans using the developed technology on the basis of the produced Agromash - 3000, Agromash-4000 combines will significantly reduce crushing losses and reduce energy costs for post-harvest processing.

Конфликт интересов

Не указан.

Рецензия

Все статьи проходят рецензирование. Но рецензент или автор статьи предпочли не публиковать рецензию к этой статье в открытом доступе. Рецензия может быть предоставлена компетентным органам по запросу.

Conflict of Interest

None declared.

Review

All articles are peer-reviewed. But the reviewer or the author of the article chose not to publish a review of this article in the public domain. The review can be provided to the competent authorities upon request.

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