EXPERIMENTAL STUDY ON LOW-LOSS EAR-PICKING DEVICE FOR CORN PLOT HEADER
/
玉米小区割台低损摘穗装置的优化与试验

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ABSTRACT

To address the problems of high ear loss rate and kernel breakage during the harvesting process of small-plot corn harvesters, this study optimized the material of the crop gathering chain based on the existing ear-stripping device of the corn harvester header. The rotational speed of the crop gathering chain was determined according to the corn row spacing and the forward operating speed of the harvester. This configuration ensures that when the harvester advances by one row spacing, the teeth of the crop gathering chain move to the next tooth position, thereby reducing material loss and minimizing ear loss. A virtual orthogonal experiment was conducted using three test factors: machine forward speed, crop gathering chain material, and ear-stripping roller rotational speed. The optimal parameter combination was determined as follows: machine forward speed of 0.83 m/s, crop gathering chain material composed of alloy steel + rubber, and ear-stripping roller rotational speed of 260 r/min. Under these conditions, the ear loss rate was 0.568%, effectively ensuring low-loss ear-stripping performance.

摘要

针对玉米小区收获机在收获过程中存在果穗损失率高、籽粒破碎率大的问题，在现有的玉米收获机割台摘穗装置的基础上，优化了拨禾链的材料，并根据玉米的种植株距、收获机工作速度设置了拨禾链转速，使得收获机经过一玉米种植株距，拨禾链拨齿就转到下一拨齿，既保证了资源不浪费，又使果穗损失率降到最低。并以机器前进速度、拨禾链材料、摘穗辊转速三因素为试验因素，通过虚拟正交试验，计算得到最佳组合为机器前进速度0.83m/s、拨禾链材料为合金钢+橡胶、摘穗辊转速260r/min，此时的果穗损失率为0.568%，有效保证低损摘穗作业。

INTRODUCTION

Recent research and development of corn plot harvester headers worldwide has focused on three main directions: intelligent precision control, modular multifunctional adaptability, and high-efficiency low-loss harvesting. To meet the specific requirements of plot trials, the key objective is to achieve low-loss harvesting and accurate data collection.

The corn harvester header developed by Wintersteiger (Austria) adopts OptiFlow technology, which is currently considered a benchmark in the field of plot harvester headers. This technology is specifically designed for challenging harvesting conditions such as lodged crops and mixed weeds. A split-type feeding auger is used to optimize crop material flow, effectively reducing the risk of blockage that often occurs in conventional headers and enabling multifunctional operation. In addition, the compression drum ensures that the crop plants are aligned and efficiently conveyed to the threshing device, thereby maintaining the accuracy and reliability of plot harvesting experiments *(Hao et al., 2007; Ji et al., 2006)*.

Recent plot harvester headers developed abroad are generally equipped with hydraulic adjustment systems (e.g., adjustment of the snapping plate gap) and sensor-based monitoring systems. The header developed by Wintersteiger allows adjustment of the harvester guide rails directly from the cab, which greatly improves the accuracy of plot harvesting experiments. It also supports row spacing customization, and the row units can operate in either floating or fixed modes, enabling effective adaptation to uneven terrain.

To meet the strict requirements for grain integrity in plot experiments, foreign harvesters commonly employ non-mixing seed conveying systems and low-damage harvesting designs. These designs ensure that harvested crops are conveyed evenly and gently, thereby preventing mixing between plots and avoiding contamination of experimental data.

The small plot corn harvester cutting table in foreign residential areas has been upgraded from a simple "harvesting" function to a precision testing equipment that integrates precise control, intelligent monitoring, and multifunctional adaptation. The focus of its research and development is on how to minimize grain loss and breakage rate while operating efficiently, ensuring the accuracy of experimental data.

Wintersteiger, as a globally leading brand for breeding and experimental machinery, has shifted its latest research and development focus from the traditional "small-plot corn harvester header" to a modular, multi-crop compatible universal header system. At present, its latest technological achievements are mainly reflected in the Quantum series and OptiFlow technology. Latest research and development status: Wintersteiger's latest research and development direction is to reduce the number of dedicated cutting headers and upgrade technology to make one cutting header adaptable to multiple crops. This header eliminates the need for separate headers for crops such as corn and rapeseed. Instead, it uses a split feeding auger and squeezing drum technology to achieve "one machine for multiple uses". At present, Wintersteiger's Quantum series (including Core, Plus, and Pro models) represents the latest generation of plot harvesters. For corn harvesting, this series primarily offers two types of header solutions: headers designed specifically for corn-growing regions, featuring a non-hybrid conveyor system and hydraulically adjustable ear-picker guide rails. It enables damage-free corn harvesting and supports operation under narrow row spacings (e.g., 60 cm, 75 cm), making it highly suitable for precise harvesting in breeding experimental fields. As a row-planted crop harvester, this is a modular machine capable of harvesting wide-row crops such as soybeans and corn by replacing different picking elements. It features a floating unit design that can perfectly adapt to irregular terrain and achieve a low cutting height.

Compared with foreign countries, the development of small-plot corn harvesters in China started relatively late. Before the reform and opening up, China had not yet developed small-plot corn harvesters, and breeding and harvesting mainly relied on manual labor (*Guo et al., 2015: Jiang et al., 2021; Wang et al., 2019; Zhao et al., 2024*). It was not until the 1980s that relevant research gradually began. Nevertheless, after more than 30 years of stagnation, research on small-plot corn harvesters in China remained basically blank. The late start and slow development have not only slowed down the upgrading speed of corn varieties but also seriously restricted the overall progress of the breeding industry (*Shao et al., 2025; Zhang et al., 2015*). For a long time, small-plot corn harvesting has mainly been conducted manually, with low efficiency. After corn maturation, timely harvesting is required. If rainy weather occurs, corn ears are prone to sprouting or molding on the plants. Due to high research and development costs, technical difficulties, and long return cycles associated with breeding machinery, most large enterprises are unwilling to enter this field, resulting in the slow development of breeding equipment in China (*Chen et al., 2023*). However, market demand for breeding machinery has always existed, so many small teams have begun to carry out independent research and development attempts.

Field plot breeding is an important way to screen high-quality seeds, and the small-plot corn harvester is one of the key pieces of machinery in the breeding process. To obtain accurate experimental data during plot harvesting, it is essential to reduce the seed breakage rate and ear loss rate (*Li et al., 2017; Vodounnou et al., 2020*). The small-plot corn harvester plays a key role in improving breeding efficiency and ensuring data accuracy. The harvesting header is an important component of the small-plot corn harvester. As the core part of the harvesting header, the ear-picking device directly affects the quality of harvested corn ears. The selection of ear-picking plate material and the setting of the feeding auger speed both influence the accuracy of plot test results, so proper selection of materials and working parameters is crucial. Reducing the seed breakage rate and ear loss rate is of great significance for improving the mechanization level of China’s seed industry, breaking foreign technological blockades, achieving rapid development of the seed industry (*Shi et al., 2023*),

MATERIALS AND METHODS

Analysis of the working process and existing problems in the picking process

Overall composition and working process analysis of the ear-picking device

The corn ear-picking device is mainly composed of an ear-picking roller, an ear-picking plate, and a gathering chain (*Chinese Academy of Agricultural Mechanization Sciences*, *2007; Shi Yi,2023*), and its three-dimensional model is shown in Figure 1.

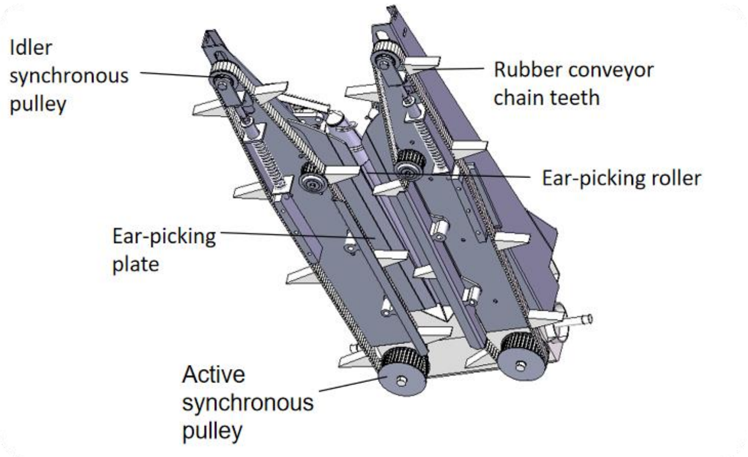

Fig. 1 - Three-dimensional structure of the ear-picking device

During the harvesting process, as the harvester moves forward, corn stalks enter the conical region of the ear-picking rollers under the action of the gathering chains and are conveyed to the ear-picking zone by the spiral cones. Under the combined action of the gathering chains and ear-picking rollers, the plants are pulled downward and backward. When the larger end of the ear contacts the ear-picking plates, its diameter exceeds the gap between the plates, and due to the brittle connection between the ear and the stalk, the ear is easily detached by the rotating rollers, thereby completing the ear-picking process. The detached ears are then conveyed by the gathering chains to the chopper and subsequently transported horizontally to the feeding inlet of the header by the rotation of the chopper.

Problems and solutions in the process of ear picking

The seed breakage rate is relatively high. The gathering chain made of alloy steel is excessively rigid. At the moment of contact with the corn ear, it produces an impact that damages or even detaches the corn kernels, resulting in inaccurate final seed data. The solution is to use alloy steel as the inner embedded layer, with an outer layer wrapped in flexible rubber. In this way, the design can not only ensure the original strength of the gathering chain but also minimize the instantaneous stress upon contact, thereby reducing the seed breakage rate.

The ear loss rate is high. When the gathering chain conveys corn ears, an excessively fast conveying speed will cause the ears to bounce on the header, thereby increasing the ear loss rate. Conversely, if the conveying speed of the gathering chain is too slow, corn stalks will accumulate in the header area, resulting in header blockage.

The working speed of the machine does not match the rotational speed of the ear-picking roller. When the speed of the ear-picking roller is excessively high, it will pull the stalks violently, leading to the loss of corn ears. When the speed is too low, the conveying of corn stalks will be inefficient and unsmooth, causing the header blockage.

Design of the ear-picking device

Design of the gathering chain

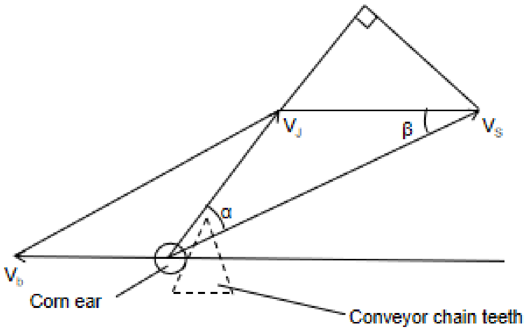

Fig. 2 - Force analysis of a corn ear during gripping by the gathering chain

As shown in Fig. 2, a mature corn plant is selected as the research object. Based on the study by Wang Zhongbo, three replicates were set up. In a 5 m long plot, it took 6 s to harvest the corn, so the normal working speed of the harvester is approximately 0.83 m/s. Under this condition, the working speeds of the harvester used in this study are 0.73 m/s, 0.83 m/s, and 0.93 m/s, respectively. At the instant when the corn plant contacts the ear-picking roller, the speed at the contact point can be calculated using the following formula. However, when setting the rotational speed of the ear-picking roller, it is necessary to not only ensure the normal operating speed of the harvester but also prevent the header from pushing the corn plant. Thus, the following relationship can be obtained:

$$V_b = \frac{(V_S/cos\delta)}{cos(\alpha+\beta)} \tag{1}$$

$$V_h = V_b sin(\alpha+\beta) - ((V_S/cos\delta) sin\alpha \tag{2}$$

$$V_b \geq \frac{V_S}{cos\beta cos\delta} \tag{3}$$

where:

V_S is the normal operating speed of the harvester, [m/s]; V_b is the conveying speed of the gathering chain, [m/s]; V_J is the relative velocity of corn plants, [m/s]; δ is the inclination angle of the header, [°]; α is the angle between the corn stalk velocity direction and the normal to the machine harvesting direction, [°]; β is the top angle of the gathering chain, [°].

Since the designed top angle of the gathering chain is β = 15° and the header inclination angle is δ = 30°, substituting β, δ and the obtained V_S into the above formula yields $V_b \geq 0.996$ m/s.

When the speed of the gathering chain is too slow, the corn stalks cannot be pulled into the picking device and are pushed over, resulting in ear loss and missing ears. When the chain speed is too fast, the corn ears will be impacted by the chain on the header and bounce, leading to an increase in the ear loss rate and seed breakage rate (*Bao et al., 2024*). Proper selection of the gathering chain speed plays a significant role in improving the operating efficiency of the harvester. According to the calculated results, the gathering chain speed is set to 1 m/s in this study

The selection of the material for the gathering chain

The process from the contact of the gathering chain with the corn stalk to the shedding of the ear can be regarded as uniform linear motion. When the material of the gathering chain remains unchanged and is still alloy steel, the hardness of the chain links is much greater than that of corn kernels. When the chain links approach the corn ear at a certain velocity, the instantaneous contact pressure generated at the interface exceeds the yield strength of the corn kernels, causing surface indentations or even cracking of the ear *(Li et al., 2024)*. Rubber materials exhibit excellent elasticity and damping characteristics. During collision, deformation occurs and absorbs most of the impact energy, thereby prolonging the collision contact time and reducing damage caused by the impact force *(Qu et al., 2025)*. After replacing the material of the corn conveying chain, the teeth of the chain will deform upon contact with the ear until the speed of the corn stalk equals that of the chain, at which point the interaction ends.

So, in order to maintain the original strength of the gathering chain, it is selected to use alloy steel as the inner embedded layer, and the layer is covered with flexible rubber, which can not only maintain the original strength but also reduce the seed breakage rate.

Design of the rotational speed of the ear-picking roller

A representative plot was selected in the field to measure the natural growth height of corn plants. The average plant height was determined to be h = 2576.6 mm, and the plant spacing was approximately 222 mm. The harvester working speed in the field was obtained as $V_S \approx 0.83$ m/s. The time required for the harvester to travel one plant spacing can be calculated using Eq. (4). To reduce harvesting losses, the ear-picking roller should complete a corresponding arc length while the harvester advances one plant spacing. This arc length is designed to match the effective height of the corn stalk, ensuring efficient harvesting without capacity loss *(Khatamov et al., 2023)*. Considering a retained stubble height of 0.2 m, the effective height of the corn stalk is 2.38 m. Given the diameter of the ear-picking roller is 0.068 m, the rotational speed of the ear-picking roller can be obtained from Eqs. (5) and (6). The calculated result is $\omega \approx 258.8$ r/min, and ω = 260 r/min is finally adopted.

$$t=\frac{L_Z}{V_S} \tag{4}$$

$$V_Z=\frac{H_1}{t} \tag{5}$$

$$\omega=\frac{V_Z}{r} \tag{6}$$

where:

L_Z is the corn plant spacing, [m]; V_S is the working speed of the corn harvester, [m/s]; H_1 is the natural growth height of corn stalk, [m]; V_Z is the linear speed of the ear-picking roller, [m/s]; t is the time taken by the harvester to harvest one plot, [s]; ω is the rotational speed of the ear-picking roller, [r/min]; r is the radius of the ear-picking roller, [m].

Simulation verification

Parameter setting

The models of the ear-picking plate, ear-picking roller, and other components were established in SOLIDWORKS, and the constructed models were saved in .xt format. The established models were imported into the multi-body dynamics software ADAMS, and corresponding constraints and connection relationships were defined (*Wang et al., 2025*).

The detailed dimensional parameters of a corn plant were measured. The corn stalk has an average height of 2.29 m, a base diameter of 2 mm, an upper stem diameter of 6 mm, and an ear height of 0.827 m. ADAMS was used to conduct virtual simulation and analysis of the ear-picking process, and various state parameters during the process were set to ensure the accuracy of the experiment. In ADAMS, the placement point Marker1 and end point Marker2 of the corn stalk were defined, with the orientation set to On to Ground. The coordinates were set as Marker1 (360, 0, 0) and Marker2 (360, 2290, 0). The material was set to wood, with a Poisson's ratio of 0.33, a Young's modulus of 1.1×10^{10} N/m², and a corn stalk density of 450 kg/m³. Subsequently, the corn stalk was modeled by sequentially executing the commands: Build → Flexible Bodies → Discrete Flexible Link. The flexible body modeling process of the corn stalk is shown in Fig. 3.

Name: jiegan
Material: wood
Segments: 14
Damping Ratio: 1.0E-05
Color: GREEN
Marker 1: MARKER_10
Attachment: flexible
Marker 2: MARKER_11
Attachment: free
Cross Section: Solid Circular
Diameter: 10

Fig. 3 - Flexible corn plant

A rotational joint and driving force were applied to the end of the ear-picking roller, and the ear-picking plate was fixed according to its actual installation position. Owing to the complexity of configuring the motion of the harvesting device, based on the principle of relative motion, the ear-picking roller was set to rotate at a speed of 260 r/min, with no additional movement applied to the picking device. Meanwhile, the corn stalk was set to move toward the picking device at a velocity of VZ = 0.83 m/s. During the picking process, with the rotation of the ear-picking roller, the blades on the roller pull down and cut the corn stalk, and the corn ear comes into contact with the ear-picking plate. However, due to the small gap between the ear-picking plates and the brittle nature of the ear stalk, the stalk is prone to breakage *(Wang et al., 2025)*. In the simulation, the corn ear and the ear stalk are regarded as an integral component, and the ear stalk is connected to the corn plant through a flexible joint, which enables the ear stalk to produce elasticity to resist external bending forces *(Zhang et al., 2024)*.

Virtual job simulation analysis

Fig. 4 shows the simulation process of the picking device. Fig. 5 presents the force curve of the corn plant when the harvester operates at a speed of V_D and the picking roller rotates at 260 r/min.

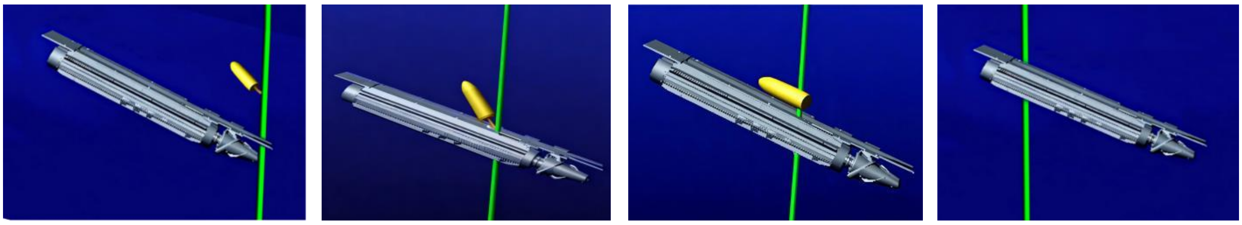

Fig. 4 - Simulation of the ear picking process

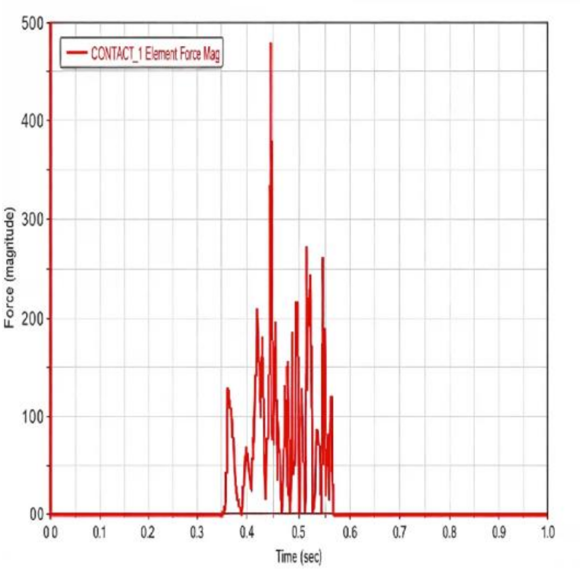

Fig. 5 - The curve of force versus time

It can be seen from the figure that at t = 0.35 s, the force begins to increase, indicating that the corn stalk starts to enter the guide cone section. The force reaches its peak at approximately t = 0.37 s. The plant then enters the picking section under the action of the guide cone, where it is squeezed downward by the left and right picking rollers and moves downward. At the same time, the corn ear is blocked by the picking plate. When the pulling force on the ear stalk exceeds its bearing limit, the ear stalk breaks and the ear is forcibly picked. The maximum force at this moment is approximately 480 N. Subsequently, under the action of the gathering chain, the corn ear moves toward the horizontal screw conveyor device, while the upper part of the corn plant continues to move downward until the picking operation is completed at t = 0.57 s.

The displacement curve of corn stalk under different rotation speeds of the picking roller is shown in Figure 6.

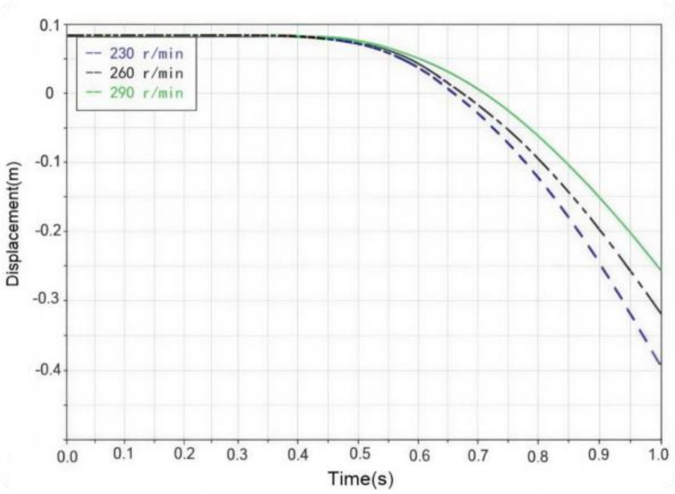

Fig. 6 -The displacement curves of corn stalks at different rotational speeds

It can be seen from the figure that at approximately t = 0.5 s, the displacement of the corn plant begins to change significantly, indicating that it starts to enter the ear-picking section.

The fluctuations in the curves observed under different rotational speeds are attributed to the fact that varying speeds result in different displacement magnitudes within the same time interval. As the rotational speed gradually increases, the efficiency of the ear-picking operation also improves accordingly.

According to the above analysis, when r ≤ 230 r/min, the ear-picking time is excessively long, the forward displacement of the machine is large, and straws may accumulate in the ear-picking area, resulting in blockage. Conversely, when r ≥ 290 r/min, the corn stalk is subjected to an excessive force, which may cause stalk breakage.

RESULTS

Field trials and conclusion

Experiments were conducted at a corn breeding experimental base in Changchun, Jilin Province in October 2025, as shown in Fig. 7.

Fig. 7 - Field trial

Design of simulation experiments

According to the current national standard GB/T 21962-2020 Technical Conditions for Corn Harvesters (*Chinese Academy of Agricultural Mechanization Sciences, 2007*), the ear loss rate and seed breakage rate are key indicators for evaluating the qualification of a corn harvester. The objective of designing the corn plot harvesting header is to reduce both the ear loss rate and seed breakage rate.

The formulas for calculating the ear loss rate and the seed breakage rate are as follows:

$$X=\frac{P_2}{P_1}\times 100\% \tag{7}$$

$$Y=\frac{Q_2}{Q_1}\times 100\% \tag{8}$$

where:

X is the ear loss rate, [%]; P_1 is the total weight of harvested corn ears, [kg]; P_2 is the weight of lost corn ears, [kg]; Y is the seed damage rate, [%]; Q_1 is the total weight of harvested seeds, [kg]; Q_2 is the weight of broken seeds, [kg].

One plot was randomly selected for harvesting. All lost corn ears on the ground and broken seeds in the plot were collected. The experimental data were processed to calculate the average ear loss rate and seed breakage rate, and the experiment was repeated.

Three factors, namely the material of the gathering chain, the machine forward speed, and the ear-picking roller speed, were selected to carry out a three-factor, three-level orthogonal experiment. The factor-level table is shown in Table 1.

Table 1

Orthogonal experiment factor level table

Encoding	Factor		
	A: material of the gathering chain	B: machine forward speed [m/s]	C: the speed of the picking roller [r/min]
-1	alloy steel	0.73	230
0	Rubber + alloy steel	0.83	260
1	Rubber	0.93	290

Table 2

Test results

Serial	Factors			Evaluation indicators	
Number	**Material of the gathering chain**	**Machine forward speed [m/s]**	**The speed of the picking roller [r/min]**	**Corn ear loss rate [%]**	**Seed damage rate [%]**
1	Rubber	0.73	260	2.15	1.12
2	Alloy steel	0.73	260	1.64	1.32
3	Rubber + Alloy steel	0.73	230	1.89	1.14
4	Rubber + Alloy steel	0.73	290	1.97	1.21
5	Rubber	0.83	230	2.04	1.08
6	Alloy steel	0.83	230	1.66	1.36
7	Rubber	0.83	290	2.03	1.19
8	Alloy steel	0.83	290	1.76	2.10
9	Rubber + Alloy steel	0.83	260	1.29	0.95
10	Rubber + Alloy steel	0.83	260	1.29	0.95
11	Rubber + Alloy steel	0.83	260	1.34	1.00
12	Rubber + Alloy steel	0.83	260	1.23	0.89
13	Rubber + Alloy steel	0.83	260	1.38	1.04
14	Rubber	0.93	260	1.63	1.21
15	Alloy steel	0.93	260	1.64	2.12
16	Rubber + Alloy steel	0.93	230	1.50	1.19
17	Rubber + Alloy steel	0.93	290	1.73	2.07

Significance analysis

Taking the material of the corn gathering chain, the forward speed of the machine, and the rotational speed of the ear-picking roller as experimental factors, and the corn ear loss rate and seed breakage rate as response values, an experimental analysis was carried out. The regression equation for the ear loss rate is: $F = 1.32 + 0.14A – 0.13B + 0.019C – 0.13AB – 0.028AC + 0.099BC + 0.28A^2 + 0.16B^2 + 0.27C^2$

The analysis results for the corn ear loss rate are shown in Table 3. The model has $F = 50.91$, $P < 0.0001$, indicating that the model is highly significant. The lack-of-fit term has $F = 0.42$, $P = 0.6756 > 0.05$, indicating that the lack-of-fit is not significant and there is no obvious experimental bias. For the linear terms: factors A and B have significant effects on the response values. For the interaction terms: the AB interaction is significant, while the AC and BC interactions are not significant. For the quadratic terms: A^2, B^2, and C^2 are all highly significant. The coefficient of determination of the model for ear loss rate is $R^2 = 0.9850 > 0.9$, indicating that the model can be effectively used to predict the experimental results.

The regression equation for the seed breakage rate is: $F = 0.98 - 0.29A + 0.22B + 0.21C - 0.18AB - 0.16AC + 0.23BC + 0.24A^2 + 0.22B^2 + 0.21C^2$. The analysis results for the seed breakage rate are shown in Table 4. The model has $F = 112.43$, $P < 0.0001$, indicating that the model is highly significant. The lack-of-fit term has $F = 0.12$, $P = 0.8911 > 0.05$, indicating that the lack-of-fit is not significant and there is no obvious experimental bias. For the linear terms: factors A, B, and C all have significant effects on the response value, among which A has the most significant influence. For the interaction terms: the AB, AC, and BC interactions are all highly significant. For the quadratic terms: A^2, B^2, and C^2 are all highly significant. The coefficient of determination of the model for seed breakage rate is $R^2 = 0.9931 > 0.9$, indicating that the model can be effectively used to predict the experimental results.

Table 3

Response surface analysis of ear loss rate

Source	Sum of Squares	df	Mean Square	F-value	P-value
Model	1.34	9	0.15	50.91	< 0.0001
A	0.17	1	0.17	56.58	0.0001
B	0.095	1	0.095	32.35	0.0007
C	2.002E-003	1	2.002E-003	0.69	0.4351
AB	0.068	1	0.068	23.14	0.0019
AC	3.025E-003	1	3.025E-003	1.04	0.3428
BC	0.020	1	0.020	6.68	0.0363
A^2	0.28	1	0.28	94.62	< 0.0001

Source	Sum of Squares	df	Mean Square	F-value	P-value
B^2	0.091	1	0.091	31.07	0.0008
C^2	0.25	1	0.25	85.68	< 0.0001
Residual	0.020	7	2.922E-003		
Lack of Fit	2.969E-003	3	1.484E-003	0.42	0.6756
Pure Error	0.0017	4	3.497E-003		
Cor Total	1.36	16			

Table 4

Response surface analysis of seed breakage rate

Source	Sum of Squares	df	Mean Square	F-value	P-value
Model	2.65	9	0.29	112.43	<0.0001
A	0.66	1	0.66	252.82	<0.0001
B	0.26	1	0.26	99.82	<0.0001
C	0.24	1	0.24	91.00	<0.0001
AB	0.13	1	0.13	48.18	0.0002
AC	0.099	1	0.099	37.94	0.0005
BC	0.11	1	0.11	40.45	0.0004
A^2	0.20	1	0.20	77.62	<0.0001
B^2	0.17	1	0.27	63.93	<0.0001
C^2	0.15	1	0.15	28.27	0.0001
Residual	0.018	7	2.615E-003		
Lack of Fit	8.250E-004	3	4.125E-004	0.12	0.8911
Pure Error	0.017	4	3.497E-003		
Cor Total	2.66	16			

In summary, the material of the gathering chain, the machine forward speed, and the ear-picking roller speed all exert certain influences on the corn ear loss rate and seed breakage rate. By setting relevant parameters and using Design-Expert software for analysis and optimization, the optimal parameter combination was obtained as follows: the gathering chain material is rubber alloy steel, the machine forward speed is 0.833 m/s, and the ear-picking roller speed is 257.4 r/min. Under these conditions, the corn ear loss rate is 1.21% and the seed breakage rate is 1.09%.

CONCLUSIONS

Based on the analysis and improvement of existing problems with corn plot harvesters, optimization measures were adopted, including replacing the material of the gathering chain and reasonably matching the rotational speed of the ear-picking roller with the forward operating speed of the machine. Experimental verification demonstrates that the proposed optimization scheme can effectively reduce problems such as collision damage to corn ears, seed breakage, and blockage caused by the gathering chain during harvesting. Meanwhile, the operational reliability and overall harvesting quality of the machine are significantly improved. Experiments show that the selected parameter combination is reasonable and the improvement measures are feasible, which can provide a reference for the structural optimization and operational parameter matching of corn harvesters.

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