DESIGN AND TESTING OF PEANUT SIEVING PROTOTYPE MACHINE
/
花生清选筛台架的设计与试验

Dongjie LI [1], Jialin HOU *[1], Dongwei WANG [2,3], Zengcun CHANG [1]
[1] Shandong Agricultural University, College of Mechanical and Electrical Engineering/ China
[2] Yellow River Delta Intelligent Agricultural Equipment Industry Academy, Shandong / China;
[3] Qingdao Agricultural University, College of Mechanical and Electrical Engineering / China;
Tel: +86-0532-58957391; E-mail: 200701031@qau.edu.cn
Corresponding author: Hou Jialin
DOI: https://doi.org/10.35633/inmateh-73-64

Keywords: *Peanut; Impurity rate; Loss rate; Cleaning sieve; Combine harvester*

ABSTRACT
In order to address the high impurity and loss rates in the cleaning process of existing peanut combine harvesters, the design basis of the cleaning sieve was explored. Tests were conducted to determine the composition of the peanut picking fruit and the characteristics of the material suspension mixture. Additionally, the mechanical relationship between the fruit and miscellaneous mixtures and the cleaning sieve was investigated. The wind speed ranged from 8 m/s to 10 m/s, the vibration frequency ranged from 6 Hz to 8 Hz, and the inclination angle of the sieve ranged from 5° to 9°. The scavenger sieve platform was constructed and tested using Box-Behnken's central combination test method. The optimal combination of fan wind speed (9 m/s), sieve surface inclination angle (8°), and sieve vibration frequency (7 Hz) resulted in a pod impurity rate of 1.16% and a loss rate of 1.4%. The device significantly reduces impurity content and loss rate during peanut harvesting. The study's results can serve as a reference for improving the design of the peanut combine harvester cleaning mechanism and optimizing operating parameters.

摘要
针对现有花生联合收获机清选环节含杂率高、损失率大等问题，探究了清选装置设计依据，开展了花生摘果脱出物料的组成成分测定试验、混合物料悬浮特性试验，并探究了果杂混合物料与清选筛力学关系，确定风速为 8 m/s~10 m/s；振动频率为 6 Hz~8 Hz；清选筛倾角为 5°~9°。搭建形成清选筛台架并运用 Box-Benhnken 的中心组合试验方法开展试验并优化，得最优参数组合风机风速为 9 m/s、清选筛倾角为 8°、清选筛振动频率 7 Hz，对应的荚果含杂率为 1.16 %、清选损失率为 1.4 %。该装置的作业效果显著降低了花生收获环节的含杂率和损失率，研究结果可为花生联合收获机清选机构的完善设计和作业参数优化提供参考。

INTRODUCTION
Peanut is one of the main oil crops in China, with increasing annual planting and production. Improving the quality of harvesting is crucial for farmers to achieve great economic benefits. In peanut harvesting machinery and equipment, the working effect of the cleaning sieve determines the loss rate and impurity rate of peanut harvesting. Therefore, the cleaning device plays a vital role in the working effect of the whole machine. In recent years, scholars both domestically and internationally have conducted numerous studies on the cleaning methods and theories of various crops.

The cleaning device can be classified into three types based on their principles: airflow type, sieve type, and airflow sieve combined cleaning device *(Wang et al., 2022)*. The principle of airflow sorting is to utilise the difference in floating characteristics of materials to sort them. Sieve-type sorting uses the physical characteristics of the material to sort it through the vibration principle. The airflow sieve combined cleaning device is a combination of the two methods and is widely used as a cleaning method in current peanut combine harvesters. *Dongming Zhang* analysed the motion mechanism of material particles in the wind sieve cleaning device using the lattice Boltzmann method (LBM). A simulation model was established to explore the flow field distribution of airflow through the static screen surface *(Zhang et al., 2023)*. In this text, Wang Bing discusses the occurrence of pod collision, bouncing, and friction during vibrating screen operation. The author conducts orthogonal and one-factor tests to determine the pod recovery coefficient and friction coefficient. The design of a non-blocking lap type finger popping sieve is also presented *(Wang et al., 2018)*.

Wan Xingyu 's research, the influence of the inlet and the MOG outlet air velocities on the high-velocity and low-velocity areas inside the cyclone separator was gained by the CFD approach. Furthermore, a prediction model built by the response surface experiment was utilized *(Wan et al., 2023)*. Wang Bokai addressed the problems of high air-selection loss rate and high impurity rate of axial-flow peanut picker harvester in the harvesting process. Based on the physical characteristics of each type of particle in the peanut mixture and the air flow characteristics, a multi-wind system is designed and numerical simulations and tests are carried out *(Wang et al., 2021)*. According to the analyses of previous studies, it was found that the structure and working parameters of the cleaning screen device have a significant effect on the performance of the harvester *(Hou et al., 2023).*

In summary, there are still shortcomings in the cleaning process of peanut combine harvesters. In order to address this drawback, this article takes the two ridges and four row peanut combine machine as the research object. It investigates the principle of pod and impurity separation in the sieving and windrowing processes. Its purpose is to analyse the conditions of pod and impurity movement in the sieving process, to design a sieving frame and to optimise the working parameters of the sieving frame. It is also intended to lay the foundation for the establishment of the theory and technical system of the combined peanut harvesting and cleaning system in China.

MATERIALS AND METHODS

Basis for designing the cleaning screen

To explore the basis for the design of the cleaning screen, the composition of the material after peanut picking, the relationship between the pods and miscellaneous blends and the cleaning screen, and the suspension characteristics of the blends were analysed (*Wang et al, 2021, Lian et al, 2023, Yue et al, 2023, Wang et al, 2024*).

The quality of the post-picking mixture was determined and the post-picking material mainly contained pods, seedling vines, miscellaneous leaves, peanut pod stalks, weeds, seedling membranes, soil, etc. The composition of the mixture obtained after harvesting is shown in Figure 1. In addition, the various components in the mixed materials will be classified and weighed, with their proportions shown in Table 1.

Fig.1 – Composition of impurities formed after picking peanuts

Table 1

The mass proportion of peanut pod and its components

Materials	Peanut pods (%)	Stalks (%)	Seedling film, deflated pods (%)	Loam (%)
Sample 1	66.3	5.0	8.0	20.7
Sample 2	70.2	4.8	7.6	17.4
Sample 3	63.1	5.3	8.2	23.4
Sample 4	66.8	5.5	8.5	19.2
Sample 5	78.0	6.2	9.6	14.2
averages	68.9	5.36	8.38	18.98

By determining the composition of the material after peanut pod harvesting: peanut pods accounted for a range of 60% to 80%, seedling vines and stems accounted for a range of 4 % to 7 %, seedling membranes and shrivelled pods accounted for a range of 7 % to 10 %, and soil accounted for a range of 10 % to 30%.

The material after peanut harvesting is analysed and the material is varied and chaotic. As shown in Figure 2. If too much material is fed, it will cause clogging of the screen, loss of peanut shells and increase in impurities. Feeding too little material will result in a loss of power consumption of the screen. Therefore, a combination of air-screening and air-blowing cleaning methods was chosen.

Fig. 2 – Feeding material for primary cleaning

The cleaning process for peanut combine harvesters consists of two stages: vibration screening and air blowing with wind selection *(Hu et al, 2023, Pang et al, 2023)*. The first stage ensures that peanut pods flow smoothly on the screen surface. During this stage, light impurities are selected based on their geometry. Air blowing wind selection is mainly used for screening surfaces that are difficult to screen and have more complicated impurities. The use of air separates the fruit. Therefore, the air blowing wind sieve combined with the cleaning sieve is a factor in peanut harvesting. This includes the design of the screen surface structure, the design of the eccentric vibration device, the inclination angle of the screen surface, the wind speed of the fan, and the fan's adaptive position. To investigate the impact of wind selection factors, a test was conducted to evaluate the floating characteristics of pods and miscellaneous mixtures. The test process is illustrated in Figure 3 and the results are presented in Table 3.

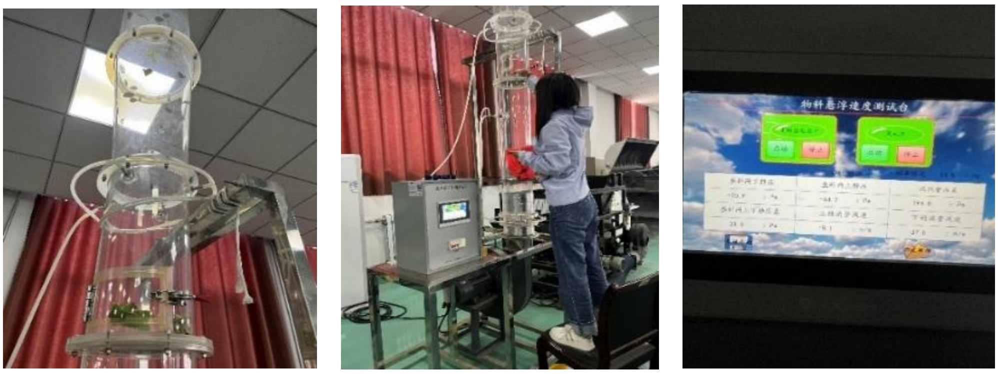

Fig. 3 – Test process

Table 2

The floating speed of peanut pods and their components

Sample name	Floating speed of material（m/s）				
	miscellaneous leaves	long stalks	short stalks	pod stalks	peanut
Ji Hua16	2.1~2.7	7.9~9.6	3.6~4.8	3.4~4.7	13.7~15.4
Yu Hua14	1.1~1.6	7.1~9.7	3.1~5.2	2.8~3.9	11.4~14.2
Da Baisha	3.1~3.8	7.6~8.7	4.8~6.8	4.3~6.7	11.8~13.3

From Table 2, it can be concluded that: the floating speed of peanut pods ranges from 11.4 to 15.5 m/s, the floating speed of long stalks ranges from 7.1 to 9.6 m/s, the floating speed of short stalks ranges from 3.1 to 6.8 m/s, the floating speed of pod stalks ranges from 2.8 to 6.7 m/s, and the floating speed of seedling branches and leaves ranges from 1.1 to 3.8 m/s.

Cleaning is based on the physical properties that distinguish peanut pods from impurities. The speed of the material floating refers to the point at which the mixture of pod and impurities is subjected to an airflow force that opposes gravity. When the forces of gravity and airflow are in balance, the mixture of pod and impurities will be suspended in the air. The pod mixture is considered as a whole and moves within an airflow with a velocity of V moving diagonally upwards. The fan configuration is directed 23° upwards along the angle of inclination of the draft collector, as illustrated in Figure 4.

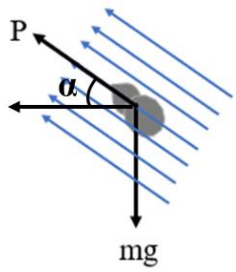

Fig. 4 – Schematic diagram of peanut and impurity wind

According to Newton's laws, the calculation formula is as follows:

$$P\sin\alpha = Gsp(V_1 - V_2)^2 \tag{1}$$

where:

G is the drag coefficient; p is the atmospheric air density, [g/m²]; α is the angle of airflow with horizontal direction, [°]; V_1 is the absolute velocity of the material, [m/s]; V_2 is the relative velocity of materials, [m/s]; s is the cross-sectional area of the material relative to the direction of air velocity, [m²].

Based on the above analysis, it can be concluded that: when $Psin\alpha < mg$, the material is in falling movement; when $Psin\alpha > mg$, the material is in rising movement; when $Psin\alpha = mg$, the material gravity and the size of the wind force is balanced.

When the material is in equilibrium, the mathematical relationship is expressed as:

$$P = GpsV_2^{\ 2} = \frac{mg}{\sin\alpha} \tag{2}$$

The floating velocity of the material is expressed as:

$$V = \sqrt{\frac{mg}{\sin\alpha Gps}} \tag{3}$$

After measuring the buoyancy of different materials, a fan is used to remove light impurities such as fruit stalks and grass shavings. The equipment achieves the best separation effect when the wind speed is set between 8 m/s and 10 m/s.

Design of screen surface structure

To enhance work efficiency and quality, the basic structure of the sieve surface is optimized based on the traditional clearing device structure, as illustrated in Figure 5.

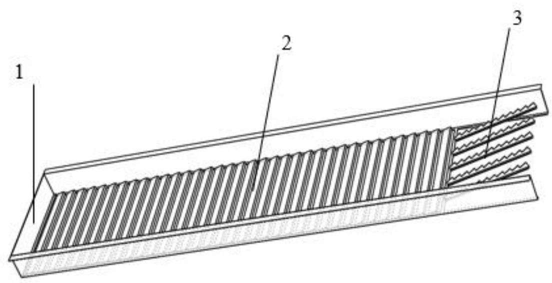

Fig. 5 – Schematic diagram of screen surface

1. Cleaning sieve racks; 2. Cleaning sieve surface; 3. Seedling discharge device

The length of the vibrating screen is primarily determined by the picking efficiency of the picking rollers. To calculate the length of the vibrating screen, use the following formula:

$$L = \frac{G_s}{bg_s} = \frac{G(1-\delta k)}{bg_s} \tag{4}$$

where:

L is the vibrating screen length, [mm]; G_s is the weight of peanuts sieved per second, [kg/s]; G is the combine harvester feed weight per second, [kg/s]; δ is the share of impurities in post-pick material, [kg/s]; K is the scavenging performance factor, [0.6-0.9]; b is the vibrating screen width, [mm]; g_s is the weight of pods fed per second, [kg/s].

According to the formula, the width of the screen is 500 mm and the length is 1540 mm. In order to make the screen work optimally, the screen is of the stepped type. This design facilitates the breaking up of the soil. At the same time, it improves the flow of the material through the screen. The parameters of the stepped screen surface are as follows: the front part of the step is inclined upwards, the back part of the step is folded and extends vertically downwards to form a step unit, and each step unit formed is evenly distributed and welded to the support frame. The screen surface is connected to a cam device, using the impact force generated by the cam rotation to convey the material backwards. The gap between the two stepped corners of the sieve surface is smaller than the diameter of the peanut pods and larger than the diameter of the impurities, so that the impurities fall smoothly. The front and rear ends are each left with a welding allowance of 2 mm, so that the gap actually takes the value of 9 mm, the length of the drafter is 400 mm, the design improves the fluidity of the material in the sieve surface and reduces the loss rate of peanut pods and the impurity rate.

Design of vibration devices

The cleaning sieve's core component is the eccentric rotation device. This device uses the principle of eccentricity to drive the vibration of the cleaning screen body and materials. As a result, the vibration amplitude and frequency are influenced by the eccentric wheel device.

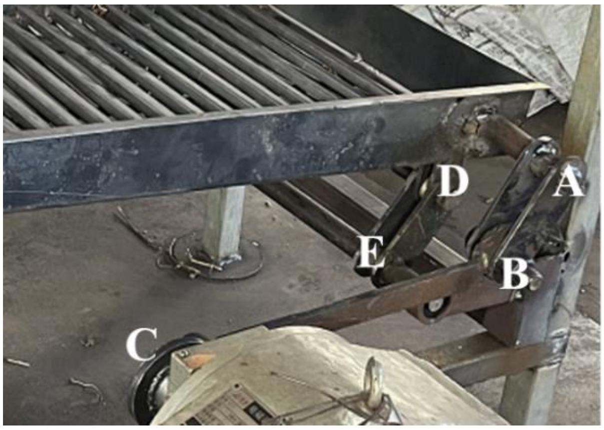

Fig. 6 – Structure diagram and prototype diagram of vibrating screen

The device operates by using the rotation of the eccentric wheel to drive the swing of the DE connecting rod. The DE rod is in a vertical state when the eccentric wheel C point reaches the farthest end. The D point is the limit point in the process of linkage swing, and the time for the D end to swing to the right is lower than the time to swing to the left.

The design aims to enable the material to move backward when it enters the cleaning sieve by causing the vibrating screen to swing back and forth. Additionally, the stepped shape of the screen surface ensures the fluidity of the material.

The cleaning sieve device's amplitude is determined by calculating the left and right swing displacement in the X direction and the up and down vibration displacement in the Y direction. The maximum and minimum moving distances of the cleaning sieve device in the horizontal direction were measured to be 2174.39 mm and 2081.42 mm, respectively, through testing.

$$A_1 = \frac{X_2 - X_1}{2} = \frac{2174.39 - 2081.42}{2} = 46.485 \tag{5}$$

The maximum travelling distance of the cleaning device in the vertical direction is 316.26 mm and the minimum travelling distance is 293.97 mm from Eq.:

$$A_2 = \frac{Y_2 - Y_1}{2} = \frac{316.26 - 293.97}{2} = 11.145 \tag{6}$$

where:

A_1 is the amplitude of scavenging device in horizontal direction, [mm]; A_2 is the amplitude of the cleaning device in the vertical direction, [mm]; X_1 is the minimum displacement of the sieving device in the X direction, [mm]; X_2 is the maximum displacement of the sieving device in the X direction, [mm]; Y_1 is the minimum displacement of the sieving device in Y direction, [mm]; Y_2 is the maximum displacement of the cleaning device in the Y direction, [mm].

The amplitude of vibration in the horizontal direction ranges from 40-60 mm according to the operating requirements of the cleaning device. The amplitude of vibration in the vertical direction is less than that in the horizontal direction. This meets the design requirements.

The vibration frequency of the cleaning device is directly proportional to the rotational speed of the main wheel, which is controlled by the motor in the eccentric device. Take the two ridges and four rows peanut combine harvester as an example, the rotational speed is calculated in the range of 400-500 r/min.

To calculate the vibration frequency, use the following formula:

$$T = \frac{60}{n} = 0.15 \sim 0.12 \tag{7}$$

$$f = \frac{1}{T} \approx 6 \sim 8 \tag{8}$$

where:

T is the time required for the active wheel to turn over one week, [s]; n is the rotational speed of the main wheel, [r]; f is the vibration frequency of cleaning sieve, [Hz].

The calculation shows that the device's frequency is between 6-8 Hz. In the peanut cleaning process, the frequency of the cleaning sieve has a significant impact on the operational performance of the entire machine. Therefore, it is necessary to further optimize this factor when determining the length of the cleaning device.

The eccentric wheel in the cleaning device uses the principle of eccentricity to provide vibration power for the screen surface, and the relative motion generated separates the pods from the impurities, which is a reciprocating simple harmonic motion. As shown in Figure 7 is the screening process movement sketch.

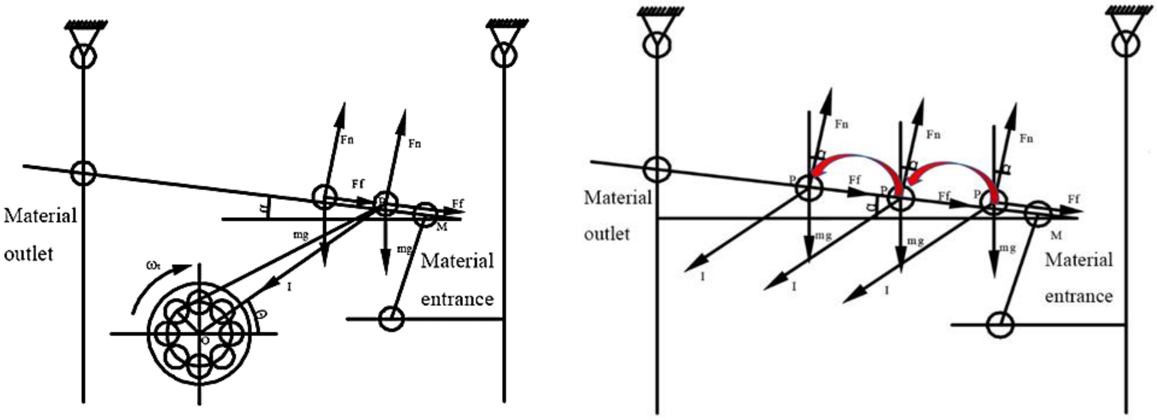

Fig. 7 – Sieve movement sketch

The expression for the motion of the clearing sieve is:

The displacement is expressed as:

$$x = -r\cos\omega t \tag{9}$$

The speed is expressed as:

$$V_x = r\omega\sin\omega t \tag{10}$$

The acceleration is expressed as:

$$a_x = r\omega^2\cos\omega t \tag{11}$$

Based on the movement of pods and impurities on the sieve surface, the equation was analysed as:

$$F_f = \mu F_n = F_n \bullet \tan\varphi \tag{12}$$

$$F_n = mg\cos\alpha - I\sin(\alpha+\varepsilon) \tag{13}$$

$$I = mr\omega^2\cos\omega t \tag{14}$$

At this time, the conditions of material movement on the surface of the clearing screen are:

$$I \bullet \cos(\alpha+\varepsilon) - mg \bullet \sin\alpha \geq F_f \tag{15}$$

The derivation yields Eq.16:

$$\frac{r\omega^2}{g} \bullet \cos\omega t \geq \frac{\sin(\varphi-\alpha)}{\cos(\alpha+\varepsilon-\varphi)} \tag{16}$$

where:

mg is the force of gravity of the material, [N]; F_f is the friction between the material and the sieve, [N]. F_n is the support force of the sieve on the material, [N]. I is the force of inertia of the material, [N]. φ is the angle of friction, °; α is the angle of inclination of the sieve, °; ε is the vibration direction angle, °.

Analysed by the formula, the motion state of the cleaning sieve is affected by the sieve surface inclination angle α. Therefore, the sieve surface inclination angle is an important factor affecting the effect of peanut cleaning, and the analysis obtained that the sieve surface inclination angle is within the range of 5°~9°.

RESULTS

Test analyses of cleaning devices

The test was conducted using a base feeding volume of 0.635 m/s for a two-ridged and four-row peanut combine harvester *(Wang et al., 2013, Wang et al., 2017))*. A test bench was constructed to verify the cleaning effect, as shown in Fig. 8. During the test, the wind speed and screen vibration frequency were controlled by adjusting the motor speed. The peanut impurity rate and crushing rate were used as indexes for test optimization.

Fig. 8 – Cleaning screen device test bench

The test equipment used included a variable frequency motor, speed controller, vernier callipers, and electronic scales, among other instruments. The peanut variety chosen for the test was the 'Yuhua 14' peanut pods outgrowth. The test was conducted at Yuanquan Machinery Co. in Yishui County, Shandong Province. To optimize the cleaning device's performance parameters, three main parameters that affect the cleaning effect were selected: centrifugal fan wind speed, sieve inclination angle, and vibration frequency.

Experimental programmer and results

Based on the operational requirements of the whole machine, the test aims to reduce the impurity rate and loss rate of peanut pods. According to the relevant test methods of peanut half-feed combine harvester, the impurity rate Z and loss rate Q of peanut pods are used as indicators to assess the operating effect of the cleaning device. Fan wind speed (Eq.3), sieve surface inclination angle (Eq.16), vibration frequency (Eq.8) as test factors, each test index can be expressed by the formula:

Peanut impurity rate:

$$Z = \frac{m'}{m} \times 100\% \tag{17}$$

where: m is the total mass of material, [kg]; m' is the mass of impurity after cleaning, [kg].

Peanut loss rate:

$$Q = \frac{v'}{v} \times 100\% \tag{18}$$

where:

v is the total mass of pods, [kg]; v' is the mass of pods lost after cleaning, [kg].

The test programme is based on Box-Behnken central combination theory. The centrifugal fan wind speed, the inclination angle of the cleaning device, and the vibration frequency were taken as the factors affecting the test. The test was conducted using a three-factor, three-level test method to verify the operational effectiveness of the cleaning and sorting device. The test code is shown in Table 3, and the test programme and data are shown in Table 4.

Table 3

Levels of test factors

Code	Experimental factors		
	Fan wind speed *A* / (m/s)	Sieve surface inclination *B* / (°)	Vibration frequency *C* / (Hz)
-1	8	5	6
0	9	7	7
1	10	9	8

Analysis of test results

Table 4

Test protocol and response values

Serial number	Experimental factors			*Z* / %	Q / %
	A	*B*	*C*		
1	8	7	8	2.13	1.48
2	9	9	8	1.67	1.36
3	9	7	7	1.31	1.42
4	8	5	7	2.06	1.62
5	9	7	7	1.3	1.51
6	9	7	7	1.24	1.52
7	10	7	8	2.17	1.53
8	10	7	6	1.57	1.98
9	8	7	6	2.45	1.21
10	10	9	7	1.16	1.52
11	8	9	7	1.53	1.57
12	9	7	7	1.22	1.45
13	9	5	8	2.34	1.73
14	10	5	7	1.47	2.24
15	9	7	7	1.23	1.41
16	9	9	6	1.72	1.57
17	9	5	6	2.11	1.81

Multiple regression fitting analysis was carried out on the data in Table 5 using Design-Expert software. Response surface regression models of the test metrics on fan wind speed, device inclination, and frequency were established. The corresponding analysis of variance (ANOVA) was carried out using the equations. As shown in Table 5.

Table 5

Detailed Analysis of Variance

Source	Impurity ratio *Z* / %				Loss ratio *Q* / %			
	Sum of squares	Degree of freedom	F	P	Sum of squares	Degree of freedom	F	P
Model	3.02	9	146.05	<0.0001	0.93	9	31.75	<0.0001
A	0.41	1	176.09	<0.0001	0.24	1	74.13	<0.0001

Source	Impurity ratio *Z / %*				Loss ratio *Q / %*			
	Sum of squares	Degree of freedom	F	P	Sum of squares	Degree of freedom	F	P
B	0.45	1	196.20	<0.0001	0.24	1	73.07	<0.0001
C	0.026	1	11.5	0.0116	0.028	1	8.48	0.0226
AB	0.012	1	5.26	0.0555	0.11	1	34.45	0.0006
AC	0.21	1	92.00	<0.0001	0.13	1	39.78	0.0004
BC	0.02	1	8.52	0.0224	4.225E-003	1	1.30	0.2923
A^2	0.18	1	78.82	<0.0001	0.046	1	13.98	0.0073
B^2	0.032	1	14.02	0.0072	0.12	1	38.01	0.0005
C^2	1.58	1	686.78	<0.0001	1.078E-003	1	0.33	0.5832
Residual	0.016	7			0.023	7		
Lack of Fit	9.100E-003	3	1.73	0.2979	0.013	3	1.62	0.3178
Pure Error	7.000E-003	4			0.01	4		
Cor Total	3.04	16			0.95	16		

Table 5 shows that the P-values of the test results for impurity content and loss rate are less than 0.01, indicating that the factors affecting these variables are highly significant. Additionally, the P-values of the loss-fitting terms were all greater than 0.05, demonstrating a good fit of the factors to the impurity content and loss rate of peanut pods. During the experiment analysis, the regression model for the experimental indicators was optimized. After removing insignificant terms in the analysis process, the optimized formula was obtained.

$$Z = 1.26 - 0.23A - 0.24B + 0.057C + 0.23AC - 0.07BC + 0.21A^2 + 0.087B^2 + 0.61C^2 \tag{11}$$

$$Q = 1.46 + 0.17A - 0.17B - 0.059C - 0.17AB - 0.18AC + 0.1A^2 + 0.17B^2 \tag{12}$$

Analysis of model interaction terms

Based on the results of Table 5, the effect of interaction between three factors, namely, fan air speed, clearing device inclination, and frequency, on the rate of impurity content and loss was evaluated. The response surface was plotted using software to further optimize the parameters as shown in Fig. 9.

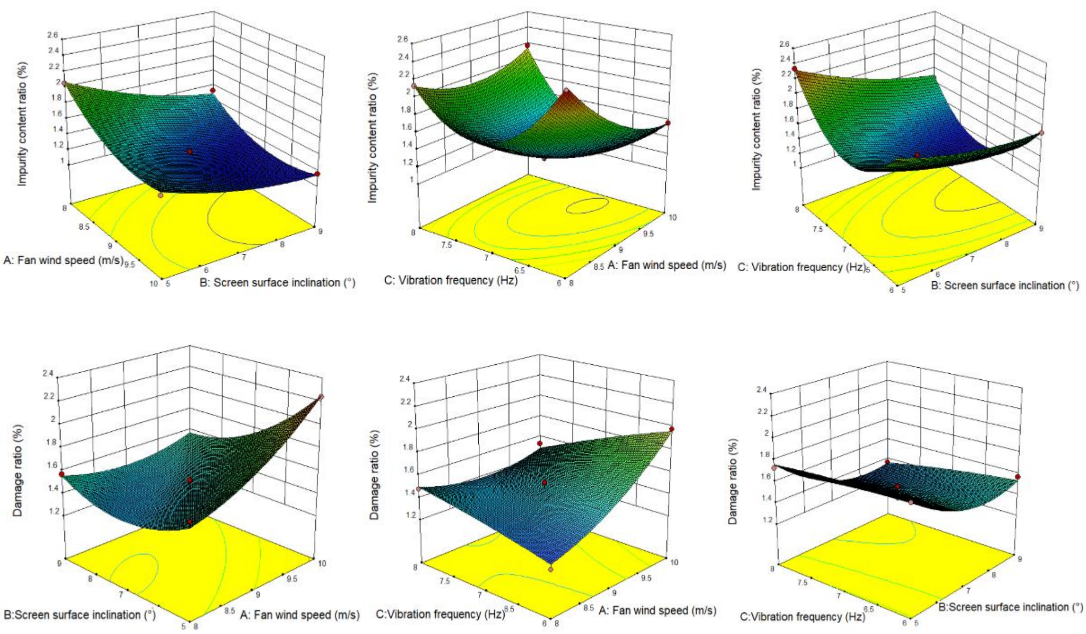

Fig. 9 – Effect of factor interactions on test indicators

The response surface analysis yields. The rate of peanut pod loss decreases as the inclination angle of the cleaning device increases, resulting in a gradual decrease in impurity rate. When the inclination angle of the cleaning device is small, the overall loss rate of peanut pods in the same period of time decreases because the flow rate of the material in the device decreases. However, if the inclination angle of the cleaning device is too large, it may cause the material to bounce and result in losses. Centrifugal fan wind speed increases, the loss rate gradually increases, the impurity rate gradually decreases. Seedling discharge device below the configuration of the fan cleaning, when the airflow is too large, results in small quality peanut pods are blown out of the cleaning sieve, resulting in losses. Clearing vibration frequency increases, the loss rate of pods increases, and the impurity content is the first to decrease and then increase. The reason is that as the output frequency of the sieve increases, the peanut pods collide violently with the sieve surface, causing the peanuts to bounce and increasing the loss rate of pods.

Parameter optimised design

The separation effect of peanut impurity materials with different parameters was investigated, the optimal parameter combinations of the cleaning and sorting device were analysed, and the objective optimisation and optimal working parameters were determined.

$$\begin{cases} \min Z(A,B,C) \\ \min Q(A,B,C) \\ s.t. \begin{cases} 8 \le A \le 10 \\ 5 \le B \le 9 \\ 6 \le C \le 8 \end{cases} \end{cases} \tag{13}$$

The Design-Expert software was used to analyse the optimal parameter combinations to obtain the lowest impurity rate and loss rate. The optimal parameter combination is: fan wind speed 9 m/s, cleaning sieve inclination angle of 8 °, cleaning sieve vibration frequency of 7 Hz, then the pod impurity rate is 1.16 %, cleaning loss rate is 1.4 %.

CONCLUSIONS

(1) This article analyses the motion between the material and the sieve surface, and concludes that the wind speed range is from 8 m/s to 10 m/s, the vibration frequency range is from 6 Hz to 8 Hz, and the inclination angle of the sieve range is from 5 ° to 9 °.

(2) Bench tests showed that the optimal combination of parameters: fan speed of 9 m/s, inclination of the cleaning screen of 8 °, and vibration frequency of 7 Hz, resulted in a peanut impurity rate of 1.16 % and a cleaning loss rate of 1.4 %. The results of this device significantly reduced the impurity rate and loss rate during peanut harvesting, and it is suitable for half-feed combine harvesters.

ACKNOWLEDGEMENT

This research was funded by Shandong Province Key R&D Program (Major Science and Technology Innovation Project) Projects and High-performance seeding and harvesting key components and intelligent operation equipment creation (Grant NO.2021CXGC010813).

REFERENCES

[1] Ciuperca R., Zaica A., Stefan V., Petcu P., Dumitrescu L., Cristea O. (2023). Research on detachment process and separation of frozen sea-buckthorn fruits from branches. *INMATEH - Agricultural Engineering*. Vol, 71, pp. 808-817, Bucharest. https://doi.org/10.35633/inmateh-71-71

[2] Fletcher, S.M., Chen, C., Zhang, P. (2009). *Competitiveness of peanuts: United States versus China*. University of Georgia, Georgia.

[3] Hou Y, Shang S, Li X., He X., Zheng H., Dong T., Li X., Yang S., Wang D. (2023). Discrete element method (EDEM) simulation and parameter optimization: Desing and testing of a low-loss and high-efficiency corn threshing device (离散元法 EDEM 仿真与参数优化：低损高效玉米脱粒装置的设计与试验). *INMATEH - Agricultural Engineering.* Vol, 71, pp. 194-204, Qingdao/China.

[4] Hu S., Chen L., Chen Z., Tan Y, Wang J, Lv X. (2023) Simulation and test of airflow field of double outlet cleaning device (双出风口清选装置气流场仿真及清选试验研究). Journal of Northeast Agricultural University, Vol. 54, pp. 67-79, Sichuan/China.

[5] Lian G., Ma L., Feng W., Wei X., Cheng X., Zong W. (2023). Design and experiment of the cleaning device with double-layer vibrating air-sieve for edible sunflower seeds. (食葵籽粒双层振动风筛式清选装置

设计与试验) *Transactions of the Chinese Society of Agricultural Engineering*, Vol. 39, pp.55-65, Wuhan/China.

[6] Pang J., Lin Y., Wang S., Du Z., Xie L., Chen X. (2023) Vibration analysis and structure optimization of grain cleaning screen based on VMD (基于 VMD 的谷物清选筛振动分析与结构优化). *Transactions of the Chinese Society of Agricultural Engineering*, Vol.39, pp. 1-9, Henan/China.

[7] Wan X., Yuan J., Yang J., Liao Y., Liao Q. (2023). Effects of working parameters on the performance of cyclone separator for rapeseed combine harvester based on CFD (基于 CFD 的油菜籽联合收获机工作参数对旋风分离器性能的影响). *Int J Agric & Biol Eng*, Vol 167, pp. 128–135, Wuhan/China.

[8] Wang B. (2018*). Pod-picking Mechanism and Screening Characteristic Research for Bottom-feeding Four Rows Peanut Combine Harvester (四行半喂入花生联合收获摘果机理与筛选特性研究).* Chinese Academy of Agricultural Sciences, Beijing/China.

[9] Wang B., Hu Z., Peng B., Zhang Y., Gu F., Shi L., Gao X. (2017). Structure operation parameter optimization for elastic steel pole oscillating screen of semi-feeding four rows peanut combine harvester (半喂入四行花生联合收获机弹指筛结构运行参数优化). *Transactions of the CSAE.* Vol. 33, pp.20-28, Nanjing/China.

[10] Wang B., Yu Z., Hu Z., Cao M., Zhang P., Wang B. (2021) Numerical Simulation and Experiment of Flow Field in Three Air Systems of Air Separation System of Peanut Pickup Harvester (花生捡拾收获机三风系风选系统流场数值模拟与试验). *Transactions of the Chinese Society for Agricultural Machinery*, Vol, 52, pp. 103-114, Beijing/China.

[11] Wang D, Shang S. Li X., Gao D. (2013). Type L cleaning separation mechanism of peanut combine harvester (花生联合收获机 L 型输送清选分离机构研究). *Transactions of the Chinese Society for Agricultural Machinery.* Vol, 44, pp.68-74, Qingdao/China.

[12] Wang F., Alym Memettrsun Zhang J., Li Q., Xu L. (2024). Design and experiment of Pre-screening cleaning device for cornbined screen surface of corn grain harvester (玉米籽粒收获机组合筛面预筛分式清选装置设计与试验). *Journal of Agricultural Mechanization Research,* Vol, 55, pp.135-147 Xinjiang/Chian.

[13] Wang S., Chen P., Ji J., Lu M. (2021). Design and experimental study of flexible threshing unit for Chinese cabbage seeds (大白菜种子柔性脱粒装置设计与试验). *INMATEH - Agricultural Engineering*. Vol. 65, pp. 333-344, Henan/China.

[14] Wang Y. (2022). *Design of the Cleaning Device for the Peanut Combine Harvester and performance studies (花生联合收获机清选装置的设计与性能研究).* Hebei Normal University of Science & Technology, HeBei/China.

[15] Yue Q, Tao G., Wang W., Zhang Z., Luo L., Xu Y. (2023). Design of grain in cleaning test bench (谷子清选试验台设计). *Agricultural Machinery Using & Maintenance*, Vol. 11, pp.1-4, Heilongjiang/China.

[16] Zhang D. (2023). *Study on Working Mechanism and experimental research of Cleaning Device for Millet (谷子风筛式清选装置筛分机理与试验研究).* Heilongjiang Bayi Agricultural University, Heilongjiang/China.