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Research Throwing Soil Regular Pattern of Reversal Cultivated Land and Fertilization Seeder

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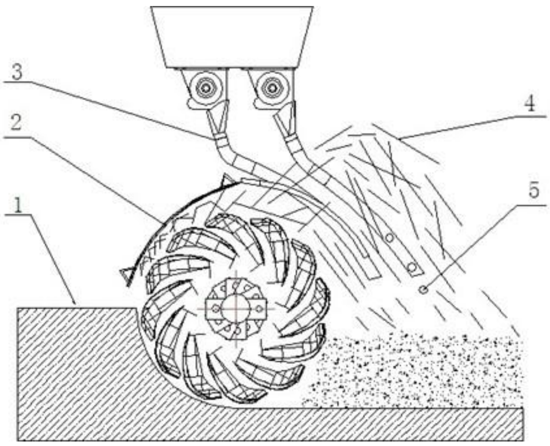
Abstract. The distribution of soil particles and planting tube space position affects reversal cultivated land and fertilization seeder seeding performance. Through the establishment of ratary tiller system coordinate system; Firstly giving the analysis of soil grain not heel cover shell collision and the first meeting with cover shell collisions motion situation, through Matlab found the first meeting with cover shell collisions will collision with spin plow knife again, and calculated separately spin plow knife in a horizontal position, tangent 45 ° direction and in vertical direction of three position of the collision curve. Findly, fitting total soil particle flow distribution curve. According to sow requirements, for agriculture combined machine seeding tube decorate location provides an important basis.

Keywords: Soil particle flow; Distribution curve; Second collision; Sowing tube; Matlab

1 Introduction

Working principle of reversal cultivated land and fertilization seeder as shown in figure 1, is 1GHB-175 agriculture combined machine using up-cut rotary way, no open ditch the way the homework, throw the soil particles into the sowing fertilizer tube of behind to cover seeds and fertilizers. According to the soil particle distribution laws, the reasonable layout of sowing pipe line, in order to realize the deep fertilization, shallow the purpose of sowing



1.Fallow land 2. Cover shell 3. Row fertilizer tube 4. Being thrown around the soil particles 5. Seeds

Fig. 1. Agriculture combined machine working principle diagram

2 Pattern of reversal cultivated land soil grain distribution calculation

Knife shaft speed for 270r/min, cover shell radius is 356mm, angle is 70. From the macro analysis, will spin tillage soil into forward throwing and backward throwing two circumstances.using calculation of back-throw ratio of soil for up-cut rotary cultivation cast soilprocess simulation program, 86.32% soil grains not with cover shell collision and then thrown back, the rest of the soil grains collision with cover shell and throw in front of the machine. In order to guarantee operation quality, must be theory discussion and analysis for the two parts are soil particles. Draw the total cast soil trajectory fitting curve, then determines the resettlement of sowing pipe line position.

2.1 No collision soil particle movement analysis

soil for up-cut rotay cultivation research, when regardless of the air resistance, was thrown soil particles motion equation is:

$$\begin{cases} x = x_o + v_x t \\ y = y_o + v_y t - \frac{1}{2} g t^2 \end{cases} \quad (2.1)$$

According to the condition of soil particle threw back :

$$\psi > \arctan\frac{v_y}{v_x} > \pi / 2$$

Can get curve equation of soil particle flow which was not collision with the cover of shell:

$$y_2 = -\frac{(x-40)^2}{28.5714} + 56 \quad (2.2)$$

In the formulas

x_o y_o——The soil was thrown the initial position coordinates;

v_x v_y——The soil was thrown initial velocity;

g——Gravity acceleration;
ψ——The velocity v direction angle

2.2 The first meeting with cover shell collisions motion situation analysis

According to the actual size of this model, establish spin plow knife static coordinate system xoy, make the shaft center of spin plow knife as coordinates xoy origin, same as the positive direction of x axis and machine driving direction. Establish the polar coordinate of cover shell $o_1 x_1$, radius is $r = 356\text{mm}$, the center of the circle at o_1, extremely angle is $a = 8°$, cover shell angle is $\beta = 70°$, o_1 and o_2 position parameter is l_x and l_y. Its space arrangement as shown in figure 2

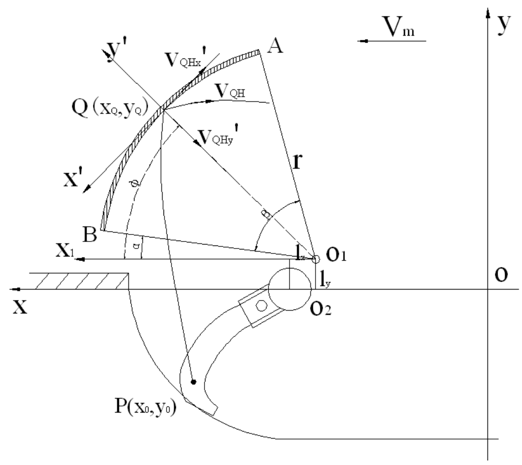


Fig. 2. Curved shell with knife shaft rotary center position relations and collision motion analysis

Assumptions are thrown soil particles point $S(r,\phi)$ and Q superposition, the coordinates in static coordinate system is S(x,y); collision point isQ, the normal and tangent pass the collision point Q and forming the Dynamic coordinate system. According to dynamic simulation of the collision of throwing soil with camber cover of rotary plow research：known cover shell parameters and soil particles being thrown around the initial velocity and direction angle, get after collision trajectory:

$$S' = \begin{bmatrix} x' \\ y' \end{bmatrix} = \left\{ \begin{matrix} (1-f)[(v_{ox}+v_m)\sin\phi - \sqrt{v_{oy}^2 - 2g(y_Q - y_0)}\cos\phi]\sin\phi \\ -(1-f)[(v_{ox}+v_m)\sin\phi - \sqrt{v_{oy}^2 - 2g(y_Q - y_0)}\cos\phi]\cos\phi \end{matrix} \right.$$

$$\left. \begin{matrix} -k[(v_{ox}+v_m)\cos\phi + \sqrt{v_{oy}^2 + 2g(y_Q - y_0)}\sin\phi]\cos\phi \\ -k[(v_{ox}+v_m)\cos\phi + \sqrt{v_{oy}^2 + 2g(y_Q - y_0)}\sin\phi]\sin\phi \end{matrix} \right\} t' + \begin{bmatrix} x_Q \\ -\frac{1}{2}g(t')^2 + y_Q \end{bmatrix} \quad (2.3)$$

2.3 Determine trajectory of soil particle flow which collision with spin plow knife again

All parameters in generation going into the type 1.3, use Matlab calculation the curve track when collision extremely sngle in 10 °, 20 °, 30, 40 °, 60 °, 50 °, ss shown in figure 3.

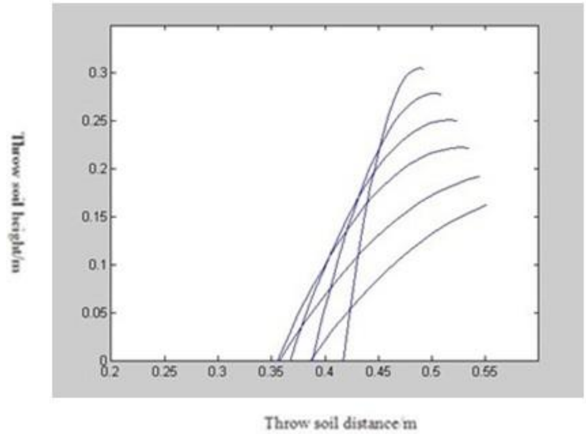


Fig. 3. soil grain after collision with cover shell trajectory

We know from figure 3 soil grain fell on 0.245m-0.490m between will collisions again with spin plow knife and thrown by high speed. according to the soil particle collisions cover shell movement analysis, similarly establish mathamatics grains and spin the plow knife collision coordinate system x_2Qy_2, as shown in figure 4 shows spin plow knife is 45°scene, the main analysis the soil particles which was thrown back by spin plow knife.

side blade of Spin plow knife curve equation is $R = R_o(1 + K\theta)$

Among them: R_o —Helical starting radius;

R —The radius of turn angle θ;

K —coefficient K=2

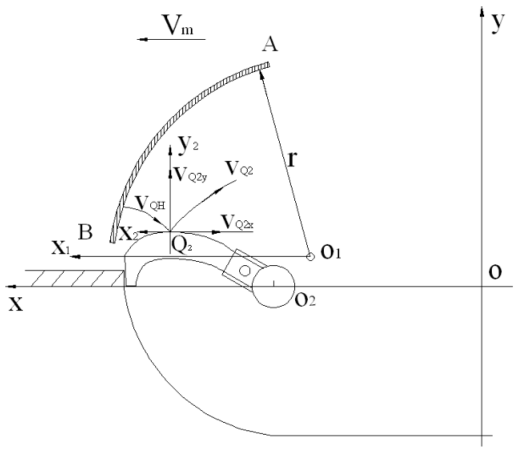


Fig. 4. collision analysis between soil grains and Spin plow knife

In this paper, using spin plow knife rotation radius is 245mm, side blade of spin plow knife spirals radius $R_O = 120\,mm$, therefore, calculate the points Q_2 location on the static coordinates xoy for (476.67 63.46), namely $x_{Q2} = 476.67$, $y_{Q2} = 63.46$.

After collision, tangential velocity that along side blade of spin plow knife point Q must consider the influence of friction coefficient. namely:

$$\begin{cases} v_{Q2x} = (1-f)v_{QHx} \\ v_{Q2y} = -kv_{QHy} \end{cases} \tag{2.4}$$

In the formula

f —Collision friction coefficient 0.4

k —Collision recovery coefficient 0.4

After soil particle S collisions spin plow knife in static coordinate system xoy will starting with Q_2 (x_{Q2} , y_{Q2}), according to v_{Q2} for initial velocity continue to do parabola, trajectory equation for

$$S^{''} = \begin{bmatrix} x^{''} \\ y^{''} \end{bmatrix} = \begin{bmatrix} v_{Q2x}t^{''} \\ v_{Q2y}t^{'} - \frac{1}{2}gt^{''2} \end{bmatrix} + \begin{bmatrix} x_{Q2} \\ y_{Q2} \end{bmatrix} \tag{2.5}$$

Generation into the parameters, Matlab calculation spin plow knife end tangent in a horizontal position, tangent 45 ° direction and vertical direction when the soil whereabouts of three position curves. As shown in figure 5, 6, 7

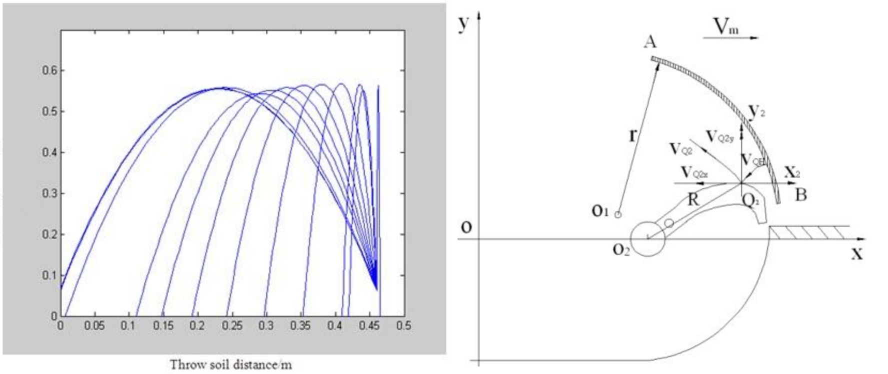


Fig. 5. Horizontal position soil distribution curve and spin plow knife position

That from figure 5 we know that most of the soil distributed in spin plow knife rotating scope inside will collision with spin plow knife again.

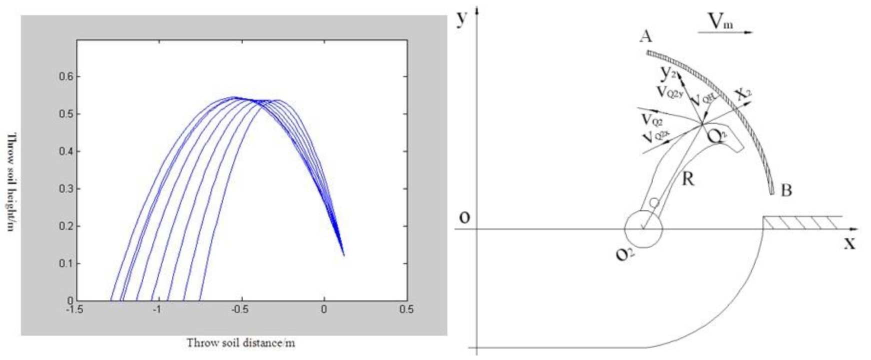


Fig. 6. tangent 45 ° direction soil distribution curve and spin plow knife position

That from figure 6 we know that soil particles is mainly distributed in between 0.75m and 1.3m.

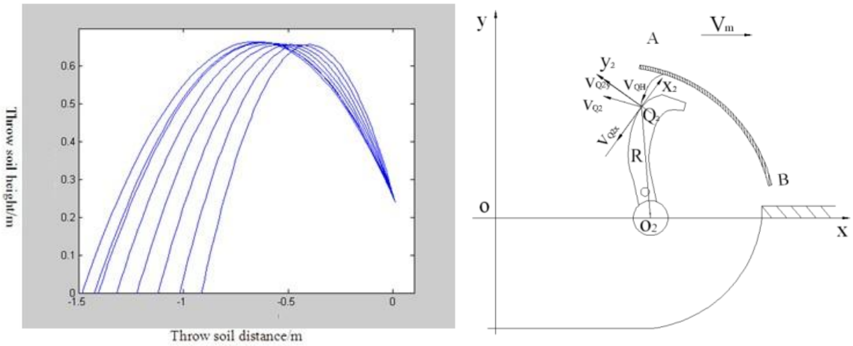


Fig. 7. vertical direction soil distribution curve and spin plow knife position

That from figure 7 we know that soil particles is mainly distributed in between 0.85m and 1.5m

According to type 2.2, assuming soil grain evenly distributed, its distribution in between 0 and 0.8m. combining figure 5, figure 6 and figure 7 knowable, the collision happened twice almost entirely throw at the soil particles that no collided rear.

3. Decorate sowing tub

From the analysis of soil grain not heel cover shell collision and the first meeting with cover shell collisions motion situation fitting two parts soil particle flow distribution, its distribution curve shown as shown in figure 8

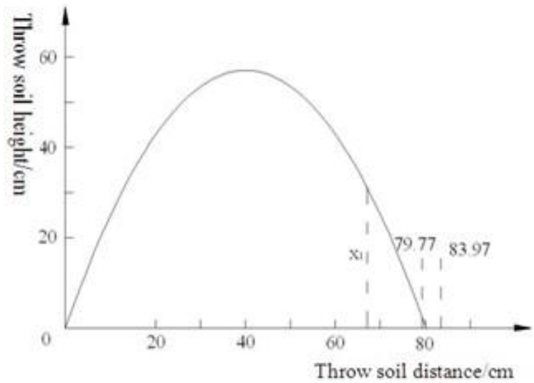


Fig. 8. Throw the soil trajectory curve, sowing decorate position and throw seeds range

The machine's spin plow depth is 15cm, planting depth is 1cm-3cm, so 6.7% to 20% soil cover seeds. Assuming thrown soil particles evenly distributed, according to the figure 8 can calculate the most distant soil particles is 6.32%, assuming critical point 6.32% coordinates is x1, through solving equations:

$$\int_{x_1}^{80}[-\frac{(x-40)^2}{28.5714}+56]dx = 2986.667\times 6.32\% \tag{3.1}$$

Can get $x_1 = 67.746$, figure 8 shows, if the pipe line at the bottom port layout online x_1. The seed will fall in between 79.77cm and 83.97c, namely seeds in the soil amount covered 1.5cm and 2.0cm, achieving the desired between planting depth.

4. Conclusion

1. No collision soil particle movement analysis, get curve of soil particle flow which was not collision with the cover of shell.
2. The first meeting with cover shell collisions motion situation analysis, give trajectory and description.
3. Use Matlab calculation the first meeting with cover shell collisions motion situation, through Matlab found the first meeting with cover shell collisions will collision with spin plow knife again. Found the collision happened twice almost entirely throw at the soil particles that no collided rear.
4. From the analysis of soil grain not heel cover shell collision and the first meeting with cover shell collisions motion situation fitting two parts soil particle flow distribution, use of distribution curve, rational arrangement of pipe line

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