THEORETICAL RESEARCH REGARDING THE WORKING PROCESS OF THE FERTILIZERS MANAGING SYSTEMS BY CENTRIFUGATION

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Keywords: administering equipment, working process, mathematical modelling.

ABSTRACT

Achieving a distribution standards per hectare as uniform and as specified by each culture is the most important objective when it comes to administering fertilizer machine. In this sense the paper aims to highlight the theoretical and experimental research conducted by specialists from home and abroad on the process of working machines administrator chemical fertilizer granulation, according to parameters that can influence this process: as blades, the angle of their and so on

INTRODUCTION

Economical and balanced usage according to the required optimum chemical fertilizers, is influenced by various factors such as the type of crop, climate and soil. Plants assimilate soil nutrients in varying amounts depending on the period of development. Likewise the necessary nutrients varies from culture to culture, so assimilation of nutritious fertilizer plant roots varies characteristics [10].

For this reason, as the fertilizer is taken closer to the plant roots, the assimilation of substances that are necessary will be more favorable. Other factors that greatly influence the process of assimilation by plants that are heat and rain conditions, but also the temperature and soil moisture, factors that play an important role in ensuring optimum nutrient intake [5].

Currently, worldwide, research is ongoing and thorough to rationalize the chemical fertilizers to ensure the requirements of nutrients of plants, so as to stop the distribution of excess, which, in time, have adverse effects on the environment and consequently on the state population health and animals.

Consistent with the culture necessary for a balanced and judicious use of chemical fertilizers is very important to know the physical, chemical and biological soil [10].

MATERIAL AND METHOD

Administering equipment by centrifugation are most used currently for managing granular fertilizers. Study the working process of these devices is important because this knowledge will allow appropriate adjustment will lead to achieving the desired distribution rules.

In this regard they have been made many researches in the country and worldwide by leading companies or research teams, to highlight the distribution function of fertilizer and the influence of different angles and shapes of the blades and distribution device on the quality process and finally working on uniformity of distribution of fertilizers.

RESULTS AND DISCUSSIONS

To ensure distribution of various types of fertilizer granules with physicochemical characteristics different qualitative conditions imposed by the agro specific cultures and to provide a wide range of standards distribution machine that carries out the work of fertilizer made up of building blocks with adjustment (eg disc blades, adjustable metering flap etc.) [5].

In the mounted equipment, the flow of material in the hopper is influenced by the geometrical shape of the hopper through the angle of inclination of the side walls as well as the size and shape of the surface of the food dispenser (FIG. 1).The equipment semi-mounted, the flow of the material is influenced, besides the angle of inclination of the walls of the hopper, the type of construction of the conveyor belt, which may be tape smooth (fig. 2) or chain type with cells (Fig. 3), and the section fall transverse distribution of the material on discs [5].

The equipment carried by the linkage of the tractor to adjust the flow of material falling on the disc / discs of distribution is carried out by means of a dosing device, by changing the opening of the outlet and the equipment semi-mounted, by changing the advance of the conveyor belt coupled with flue flap modification [10].

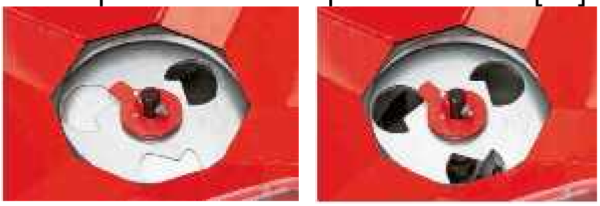


Fig. 1 - Device for adjusting the flow by modifying the outlet [14]

Fig. 2 - Flow control by adjusting the speed of the conveyor belt smooth rubber material for discs carrying [12]

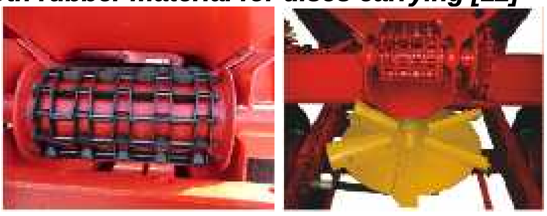


Fig. 3 - Method of regulating the flow by adjusting the rate of flow of material by means of a profiled strip [13]

The movement of material particles on the disk surface is influenced by the structural characteristics of centrifugal devices with distribution through their form and the fall of the particles on the disk.The uniformity of distribution of the material particles on the surface of the ground is only achieved if the particles are to be printed by said wheel release a certain initial speed, in the directions defined relative to the direction of movement of the aggregate. The rates of particles leave the disc and release their directions are dependent on the position of the feed disc and the movement of the material particles during the scattering disk.

How displacement of particles on the disk surface during movement and particulate matter are influenced by the following factors of importance:

- The number of discs, their diameter (Fig. 4) and the inclination of the disk surface;
- The structural characteristics of the blade (length, radius of curvature of the profile) (Fig. 5), the number of blades (Fig. 4) and their positions relative to the disc (Fig. 6).

Fig. 4 - The design of the electricity distribution:1 discand that two discs[13]

Fig. 5 - Construction characteristics of the blades [14]

Fig. 6 - Adjusting blade angles [11]

Another influencing factor is the height above ground of the disks in the composition of the distribution apparatus.

The mounted equipment is possible height adjustment of the distribution apparatus to the ground by operating the 3-point linkage of the tractor, thus changing the distribution parable.

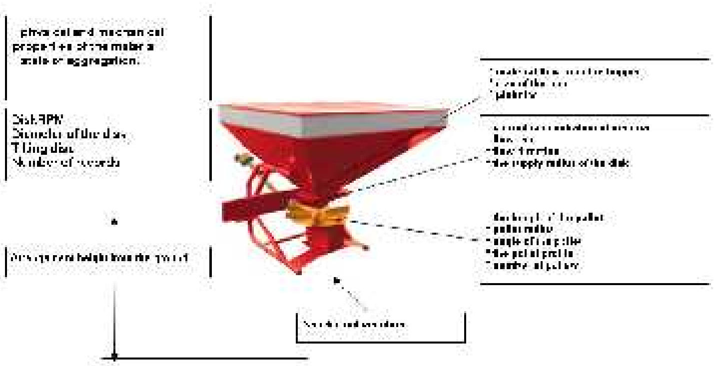


Fig. 7 - Factors that influence the working process executed Spreader mineral fertilizers by centrifugation [5]

Quality of work is influenced by the following disturbing factors:

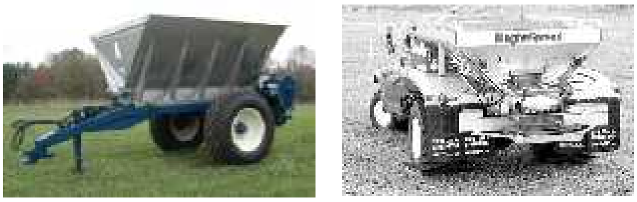
- Uneven terrain and / or the speed of the unit.

- Weather conditions: wind speed> 5 m / s and humidity> 90%, more than these limits allow for a quality work;

- Operator who has to maintain a constant engine speed, the moving direction on the surface, defined by the cones located at each end of the plot, to make appropriate adjustments on the components of the machine in order to obtain the best uniformity of spreading the material on the ground surface;

- Physico-mechanical properties of fertilizers such as natural slope angle, aggregation state, wettability etc. They are taken into account in the design and construction hopper agitator and distribution apparatus for choosing technical solutions to ensure a constant flow and distribution of fertilizers.

a)



b)

Fig. 8 - Constructive types of bunker [5]
a) worn equipment; b) semi-mounted equipment

Fig. 8 - Agitator [8]

Current trends in agricultural development are of increased agricultural production by developing mineral fertilization, but in defined amounts, controlled, without an overdose [5].The machinery used to distribute fertilizers have developed rapidly both in terms of their design and construction and in functional and technological terms.

Theoretical and experimental research conducted globally and nationally on machinery for the administration of mineral fertilizers focused mainly on processes performed by the working bodies of these cars, to establish constructive and functional parameters of the active members lead optimize work processes in order to improve quality and reduce energy consumption indices, fully consistent with the physical and mechanical properties of the material distributed and specific working conditions [15].

• THEORETICAL RESEARCH WORK ON THE PROCESS OF CHEMICAL FERTILIZER SYSTEMS ADMINISTERED BY CENTRIFUGATION

An article reviews the studies on theoretical research of the working process of systems to manage chemical fertilizers by centrifugation includes research on the movement of fertilizer granules on a flat plate components of a fertilizer article presenting the mathematical model studied [2].

This model is used to study the dependence of a withdrawal rate of fertilizer granules on the coefficient of friction and the angle adjustment.

The first works modeling process administered by centrifugation fertilizers were made after almost half a century of Patterson and Reece (1962); Inns and Reece (1962). Modeling administration process has been "reactivated" in recent years, models have been improved and new technologies have been introduced, disc spreader parameters were optimized and published a series of articles. [2, 13]

In 2005, Villette, Cointault, Piron and Chopinet created an analytical model of motion of particles of fertilizer. This mathematical model is made for a concave disc fitted with inclined straight blades. Villette et al. 2008 showed that the rate of discharge of the three-dimensional components in the case of a concave disc can be deduced from the measurement of the angle of the horizontal discharge. In 2010, Villette et al. introduced the coefficient of friction referred to as "friction coefficient equivalent". This parameter is derived from a mechanical model of the movement of fertilizer on a moving disc and angle measuring exhaust particulates. [1, 2, 6]

This article has been considered a disc scheme (Fig. 9) with radius R disc spreader; palette for driving fertilizer granules disk ψ0 is the angle adjustment palette, r - the distance between the center of the disc and fertilizer in the current position, R0 - the distance between the center of the disc and fertilizer in A0 initial position, the angle ψ between rays polar fertilizer granule, and the direction of the blade [1, 3, 16].

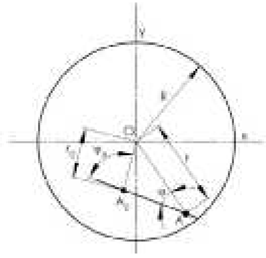


Fig. 9 – The distribution disk scheme [1]

The fertilizer granules have a complex movement on the disc (Fig. 1). The pellet is rotating with the disc (forward motion) and moves along the blade (relative movement).

The projection equation relative movement of the granule of fertilizer to the axis ξ, directed to the initial position of the granule of fertilizer A0, over the blade the edge of the distributing disc, can be prezentatăă in the form of the following (re-entered, 1995) [1 4]:

$$m\frac{d^2}{dt^2}\P(t) = F_1 + F_2 + F_3 + F_4 \qquad (1)$$

where:
ξ (t) = A_0A is the distance between the initial position and the current granule fertilizer;
F1 is the projection of friction between the disk axis ξ a distribution and range;
F2 is translational inertial force projection ξ axis;
F3 is the projection axis ξ friction caused by the inertial force of translation;
F4 Coriolis inertia force projection.
The equations of these forces are shown below [1, 10, 16]:

$$F_1 = -fmg, \quad F_2 = m\mu^2 r\cos\cdot\ , \quad F_3 = -fm\mu^2 r\sin\cdot\ , \quad F_4 = -2fm\mu\frac{d}{dt}\P(t) \qquad (2)$$

where:
m is the mass of the fertilizer granule;
ω - velocity of the disk at constant angular distribution;
f - coefficient of friction between fertilizer granules and disk array;
g - acceleration of gravity.
Forces entering F1, F2, F3, F4 in equation (1) and dividing by m, resulting differential equations with constant coefficients usual [1,6, 17]:

$$\frac{d^2}{dt^2}\P(t) + 2f\mu\frac{d}{dt}\P(t) - \mu^2(r\cos\cdot\ - fr\sin\cdot\ ) + fg = 0 \qquad (3)$$

From Figure 9. as follows:

$$r\cos\cdot\ = AA_0 + r_0\cos\cdot_0 = \P(t) + r_0\cos\cdot_0, \quad r\sin\cdot\ = r_0\sin\cdot_0 \qquad (4)$$

Adjustable angle ψ0 planet is ψ0> 0, if measured from OA0 counterclockwise and vector ψ0 <0 - where is measured in clockwise.

Taking into account the equations (4), equation (3) can be written in the following form:

$$\frac{d^2}{dt^2}\xi(t) + 2f\omega\frac{d}{dt}\xi(t) - \omega^2\xi(t) = A \tag{5}$$

where

$$A = \omega^2 r_0\left[\cos(\theta_0) - f\sin(\theta_0)\right] - fg$$

The differential equation (5) forming the granule of fertilizer on the movement plan pitch blade disc defined by the re-entered (1995) [1, 9].

It is assumed that the fertilizer granule movement to the initial position A0. In this case, the initial conditions are:

$$\xi(0) = 0, \qquad \xi'(0) = 0 \tag{6}$$

Where:

$$\xi(0) = \frac{d}{dt}\xi(t)$$

Equation (5) can be solved by classical method and the solution is:

$$\xi(t) = C\left(1 - \frac{\lambda_2 e^{\lambda_1 t} - \lambda_1 e^{\lambda_2 t}}{\lambda_2 - \lambda_1}\right) \tag{7}$$

Where : e=2.718 and

$$C = \frac{fg}{\omega^2} - r_0\left[\cos(\theta_0) - f\sin(\theta_0)\right], \quad \lambda_1 = \omega\left(-f + \sqrt{1+f^2}\right), \quad \lambda_1 = \omega\left(-f - \sqrt{1+f^2}\right)$$

From Figure 9 can deduce relationships:

$$r(t) = \sqrt{r_0^2 + 2r_0\cos\theta_0 \cdot \xi(t) + \xi(t)^2} \tag{9}$$

$$\theta(t) = \arcsin\left[\frac{r_0\sin(\theta_0)}{r(t)}\right] \tag{10}$$

where ξ and r are functions of time t: ξ = ξ (t) and r = r (t).

In equation (9), the function ξ (t) is determined by the solution (6) to the differential equation (1).During the evacuation it may be determined from the equation:

$$\xi(t_e) = \sqrt{R^2 - r_0^2\sin\theta_0^2} - r_0\cos\theta_0 \tag{11}$$

Equation (11) was solved numerically similar to you by Mathcad community.
The angle between the vectors OA0 and OA (Fig. 1) can be obtained from the equation:

$$\psi(t) = \theta_0 - \theta(t) \tag{12}$$

A rectangular coordinates of the current position of the fertilizer granules can be found by equations

$$x(t,\varphi_0) = r(t)\cdot\cos\left[\varphi_0 + \psi(t) + \omega t\right], \quad y(t,\varphi_0) = r(t)\cdot\sin\left[\varphi_0 + \psi(t) + \omega t\right] \tag{13}$$

where ω is the angular velocity of the disk and determines the angle φ0 grain original position.

Projections on the 3 axes speed and speed mode fertilizer granule are given by the following equation:

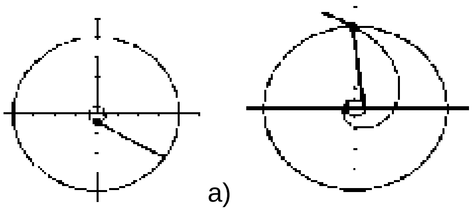
$$v_x(t,\varphi_0) = \frac{d}{dt}x(t,\varphi_0), \quad v_y(t,\varphi_0) = \frac{d}{dt}y(t,\varphi_0),$$

$$v(t,\ddot{}_0)=\sqrt{v_x\left(t,\ddot{}_0\right)^2+v_x\left(t,\ddot{}_0\right)^2} \qquad (14)$$

For the given parameters of the disk to be administered and granules of fertilizer gears (14) were determined by using numerical differentiation in the program Mathcad.

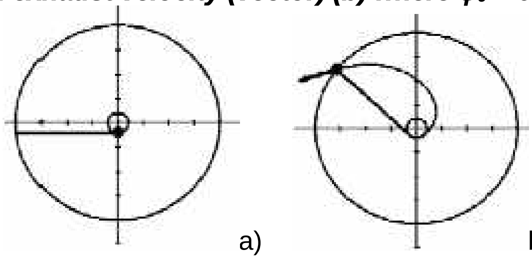
By using the mathematical model presented the methods of Aan, Heinloo [1] complexes were visualized trajectories of movement of the distribution disc granules of fertilizer. Calculation conditions were as follows: R = 0.4 m; f = 0.47; Ω = 57.6 s-1; R0 = 0.04 m, φ+ -90^0.

Figure 10 shows the initial position of the blade, and Figure 10B shows the path of the granule and the granule of fertilizer and direction output rates, when ψ0 = 60 °.



a) b)

Fig. 10 - The initial position of the blade and the granule (a), the trajectory of the granule and exhaust velocity (vector) (b) where $\varphi_0 = 90^0$, $\psi_0 = 60^0$

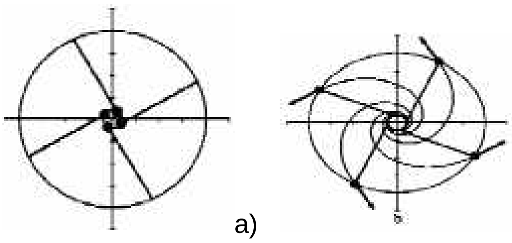


a) b)

Fig. 11 - The initial position of the blades and granule (Ia), the trajectory of the bead and exhaust velocity (vector) (b), the φ_0 = 90î, ψ_0 = - 90°

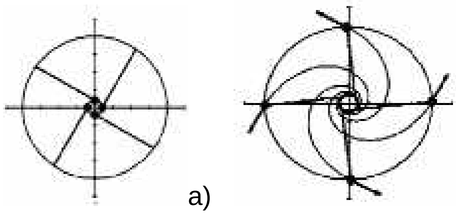
Figure 11a shows the initial position and blade and Figure 11b shows the trajectory granule fertilizer granule speed and direction of evacuation, when φ_0 -900; Ψ_0 = - 90 °. From Figures 2 and 3 that the path of the granule, where ψ0 = - 90 °, is less than in the case where ψ0 = 60 °.

Figure 12 shows the initial positions, paths and speeds for the four-blade exhaust granules and granules, where φ_0 = 60 °, 150 °, 240 °, 330 °; Ψ_0 = 60 °; Figure 13 is the relevant angles φ0 = -90 °, 0 °, 90 °, 180 °; Ψ0 = 60 °.



a) b)

Fig. 12 - Position (a) escape trajectories and velocities of granules in the case of 4 blades (b), the φ_0 = 60°, 150°, 240°, 330°; Ψ_0 = 60° [1]



a) b)

Fig. 13 - The initial positions (a), exhaust paths and speeds of granules in the case of four blades (b), where φ_0 = -90 °, 0 °, 90 °, 180 °; ψ_0 = 60 °[1]

Heiloo (2010) [1, 4] showed that the distribution polygonal discs may be used instead of circular discs.

In [1] and Heinloo Aan offers a mathematical model equipped with disc flat distribution inclined straight blades. This model describes the movement of fertilizer particle. Disc and blades. With this mathematical model, it was possible to determine fertilizer particle velocity, which depends on the initial five variables: f - friction R0 initial position of the particle paddle blade angle adjustment ψ0-, R - ray disc and ω - angular velocity disc. Comparative study of the Villette, Cointault, Piron, Chopiner (2005) flat disc uses three variables: coefficient of friction, the angular velocity of the disk and the blade pitch [1, 18, 19].

• EXPERIMENTAL RESEARCH ON THE WORKING OF SYSTEMS TO MANAGE CHEMICAL FERTILIZERS BY CENTRIFUGATION

Researchers and manufacturers of the machines administered fertilizers have paid special attention to work equipment and bodies scattering of mineral fertilizers to optimize the process of spreading the material on the soil surface, improving the quality indices of work and reducing energy consumption while complying physico-mechanical properties of the material distributed and specific working conditions.

Firms (RAUSCH, Vicon, Amazone) conduct experimental research in the laboratory, on stands that allow simulation of different conditions which may occur in service.

Modern technology based on electronics and computer broke and construction of agricultural machinery. Technical applications aimed on the one hand ensuring permanent control of the working process and on the other hand the rapid determination of optimal operational parameters. In this regard, western manufacturers' test laboratories of chemical fertilizer spreaders are equipped with stalls that allow simulation of working conditions in the field, determining quality indicators specific to this type of equipment, processing and storage of results.

Fig. 14 - The test stand for experimental machines for administered mineral fertilizer firm Vicon [14]

To enable tests at any time of the calendar year, companies Vicon (fig. 14) and Amazon (Figure 15) conducted special laboratories, thus eliminating the influence of atmospheric agents.

Fig. 15 - The test stand for experimental administering machines for mineral fertilizer firm Amazone [11]

These research laboratories are equipped stands for simulation of working conditions in the field, with the possibility of testing the uniformity of distribution.

To this end, the Spreading machine collector troughs are placed transversely with standardized dimensions.

The company's laboratory and the company Vincon Amazone [11], simulation and ground relative motion of the machine is achieved by moving the collector troughs, transverse in a row on a self-propelled whole. The test method requires sample to start with reaching the rated speed of the tractor, followed by the opening of the dispenser machine control while traveling off the set of troughs collectors.

After completing the assembly of a collector troughs remoteness of throwing out of the distribution apparatus, stops spreading and weighing the material collected in each trough.

Since the uniformity of distribution does not fall within the requirements of agro the overall width of the dispersion, the lateral ends of the strip by spreading the quantity of material distributed is much smaller than in its center, the data are processed in order to determine the width good working method overlap prescribed test standard.

Data processing is performed computerized distribution curve rising fertilizer that will be obtained when choosing to work in the field of distance between paths criss-optimal width determined by calculation.

Lab company Rauch [14] has three rows of devices for collecting a fixed side of a running path for moving the spreader unit. Each collection device capable of weighing the material collected during the tests and the transmission of values obtained from a system of data acquisition and processing. The samples were run under nominal working, following the casting must be stopped to remove the spreading of the aggregate area of the collection devices. Data processed determine the optimum working width of the machine and provides information on the distribution. This provides a fast testing of variants and immediate information on results.

In Romania there is such experimental stands, the experiment was done in the open, but following national standards for experimentation with equipment to manage granular fertilizer centrifugal SR-ISO 5960: 1995.

Such experiments were carried equipment MIC 0.4M [13] distribution apparatus equipped with centrifugal fertilizer for different working widths composed of four interchangeable rotating discs and subject patent nr.114525 / 31.05.1999 .

Equipping MIC 0.4M distribution with this device offers the possibility of using the machine on the ground so flat and small and medium plots in the hilly region, by ensuring four wide working widths: 20 ... 22 m to 7 ... 9 m.

Attempts car covers quality indexes work, energy and mining indices compared with agro-technical requirements, energy, mining and technical data provided in the patent.

Fig. 16 - Solid fertilizer spreaders MIC 0.4M [13]

Distribution device rotating centrifugal disc interchangeable for different working widths of the patent that is the subject nr.114525 / 31.05.1999, the machine offers the possibility of using both large land plots fertilized with maximum slope of 6 plain and fertilized plots SMEs in the hilly area.

The machine has the following composition: frame, tank, dispenser with 16 positions adjustment device for centrifugal spreader, consisting of mechanical transmission shaft and speed multiplier guards.

Rotating disks of centrifugal unit distribution for different working widths have diameters:

- 700 mm working width of 20 ... 22 m;- 600mm working width of 15 ... 18 m;- 450 mm working width 9 ... 10 m;
- 400 mm working width of 7 ... 9 m;

The four blades each mounted disk inclined at 30 ± 7^0 following angles Φ 700 mm disk, disk 15 ± 7^0 600 mm, -15 ± 7^0 Φ 450 mm disk and disk -15^0 ± 7^0 Φ 400 mm. Compared to the mid blades can be adjusted by ± 7^0. Those angles "+" sign in the sense of disc rotation and the sign "-" in reverse. The machine is operated by MIC 0.4M PTO horsepower tractors 45 ... 65 having a volume of 0.45 m3 hopper.

Fig. 17 - Aggregate consists of U445 tractor and car MIC 0.4M equipped with 600 mm diameter disc in work

CONCLUSIONS

In agriculture using a wide variety of fertilizers in terms of shape, size, mineral composition etc.

From the theoretical and experimtnale by researchers at home and abroad follows:

• scattering angles not more than 160^0 to obtain a chart of the distribution as close as possible the ideal shape of a trapezoid diagram of the distribution on the soil surface.

• the speed of 700 rev / min, the feed beam of between 100 and 150 mm, and the inclination of the blades forward to 30^0or 60^0, it was found that the degree of breaking of the granules is more than 40% due to the force of impact wide, leading to a low precision spraying.

• Not recommended for use discs conical without placing the filler in the area of the blades because downtime on the disc are very high, which at high speeds give high times of late particle disk and wide angle scattering.

• angle of inclination of a surface of the disc should be positioned 5^0 or 10^0because with higher speeds obtained optimal sharing between 90^0 and 120^0 fertilizers and fertilizer speed launch which did not differ significantly on the entire range rev.

• optimum speed of rotation for a proper launch speed is 540 rev / min and a radius of 170 mm blades.

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