[1.]A.M. POLOKHIN, [2.]Yu.A. KUZNETSOV, [3.]L.V. KALASHNIKOVA

IMPROVEMENT OF MEASURING DEVICES OF SEEDING MACHINERY

[1-3.] Faculty of Agrotechnics and Energy Supply, Orel State Agrarian University, Orel, RUSSIAN FEDERATION

Abstract: The design of the improved measuring devices of pneumatic seeding machines as exemplified by the pneumatic dispenser of seeding machine УПС-8 is suggested. The differential characteristics of the improved design is application of new dispenser disc and seed dropper of excessive seeds. The results of investigation of seed sowing using the suggested design are presented.
Keywords: measuring devices, seeding machines, pneumatic dispenser

1. INTRODUCTION

Modern social economic situation in the world predetermines the necessity of the accelerated development of the national agricultural production (Anokhina M.E., et al, 2016; Kushnarev L.I., 2015). It is of great importance in relation to the world food crisis, calling for the solution of problems of the country food security (Lachuga Ju.F. et al, 2009). Machinery and engineering resources of agro complex in modern agriculture are used deficiently and to implement them in the service of intensive agricultural production is the task of high priority (Emelyanov P.A. et al, 2016; Kostikov I. F. et al, 2016). At growing agricultural crops seeding machines occupy special place, especially, pneumatic seeding machines of precision seeding, because it is impossible to harvest high yield without high-quality seeding. Dispensers of pneumatic seeding machines of precision seeding were developed and improved in several directions (Kanunnikov P.P. et al, 2013):

— improvement of seed selection by dispenser (disc) – form, profile of vacuum opening, vacuum;
— creation of seeds active layer (usage of agitators directly near disc);
— creation of condition for single seed selection (seed droppers of different forms);
— creation of conditions for reduction of seeding machine readjustment period and labour facilitation (application of different disc plates);
— improvement of seed flow process from tanker (tanker form, application of different agitators);
— providing the guaranteed release of dispensers (cells cleaning), seed ejector blades, etc.

To increase the quality of seed dispensing process by seeding mechanism one can examine two ways of improving: seed disc modernization and application of new seed dropper of excessive seeds. Modernization of seeding disc (figure 1) consists in mounting on disc 1 from the side of vacuum chamber jumper 4, which is fixed to the disc in slot 3 and gets through centers of vacuum openings 2 (Kalashnikova N.B. et al, 2013). More than that jumper has lugs 5, which get into vacuum openings, into their by the depth equal to half of the disc thickness.

This improvement allows decreasing of vacuum openings obstruction whereby increasing one-grain seeding quality. Besides, the suggested engineering design is simple in production and can be used for modernization of already existed seeding machines (particularly, seeding machines UPS-8 (universal pneumatic seeding machine).

The main idea of new seed dropper (figure 2) consists in the following: on rod 1, on one end, there is handle 2 with spring 3, and on the other end clamp 4 with elastic gripper in the form of brush 5 is fixed (Kalashnikova N.B. et al, 2013).

The suggested engineering design provides precision one-grain seeding and change of setting angle of elastic gripper of dropper allows sowing of seeds of different fractions, and so expands opportunities of application of seeding mechanism. More than that there is a possibility to adjust the seeding mechanism without its dismount easily and quickly (Chernoivanov V.I. et al, 2012; Sorokin N.T. et al, 2016).

The suggested improvements of seed disc and dropper design were tested in the laboratory and field conditions.

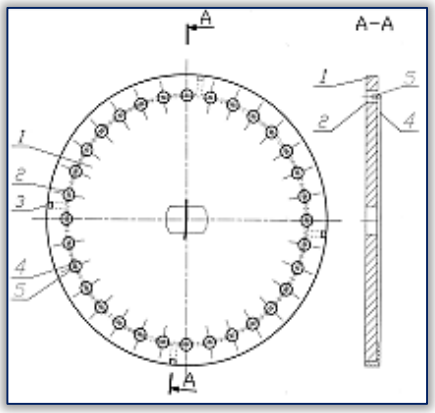

Figure 1 - Suggested seed disc with mounted jumper: 1-seeding disc; 2- vacuum opening; 3-slot; 4-jumper; 5-lug on jumper

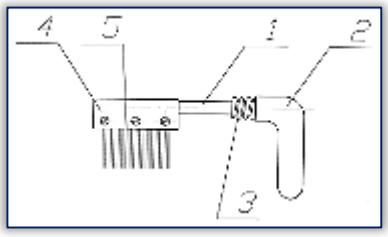

Figure 2 - Overview of excessive seeds dropper 1-rod; 2-handle; 3-spring; 4-clamp; 5-brush

2. MATERIAL AND METHOD

The experimental method consists in change and control of three factors (table 1). Indicators of basic level of the factors of peripheral speed of cells correspond to seeding machine motion with speed 9 km/h, vacuum value in vacuum chamber – to average value of control limits of vacuum value according to the operations manual of seeding machine UPS-8 (universal pneumatic seeding machine). Single seed feeding by seed disc cell M (pc.) was considered as optimization parameters, at that, $M \longrightarrow 1$ and zero delivery of seeds by cell p_0 (pc.), at that $p_0 \longrightarrow 0$.

Table 1. Basic factors and levels of their variations

Factor name	designation	Factors levels			Variability interval
		Minimum (-1)	Basic (0)	Maximum (+1)	
Cells peripheral speed of seed disc [m/s]	X_1	0,29	0,33	0,37	0,04
Vacuum value in vacuum chamber [kPa]	X_2	5	5,5	6	0,5
Position of excessive seeds dropper	X_3	5	6	7	1

Laboratory tests were done on Orel State Agrarian University experimental base on the self-engineered installation (figure 3a), that allows recording of seed sowing with detection of double sowing and sowing gate-passes in different modes of seeding mechanism. The installation consists of the following engineering elements: seeding mechanism 1 of seeding machine UPS-8 (universal pneumatic seeding machine), electromotor 2 for seed disc drive, vacuum meter 3 of company «Westfalia» for vacuum control in seed chamber, piezoelectric sensor 4 (piezoelectric sensor of grain losses – PSGL-1), strain-gauge station A17-T 5 with sampling frequency 25000 Hz operating in the mode of oscillograph, notebook 6 for recording and notation of the data obtained.

3. RESULTS

As the result of the experimental data processing it was proved that one-grain feeding by the seed disc cell M, is in the limits of $1 \leq M \leq 1{,}025$pc, at that $M \longrightarrow 1$, and zero seed delivery by cell is $p_0 \leq 0{,}02$ pc.

a) 1-serial seeding mechanisms, 2- experimental seeding mechanism b)

Figure 3 – General view of installation for tests in laboratory conditions (a) a seeding machine with experimental seeding section (b)

The field tests were done at the Shatilovskaya agricultural experimental station in the Novodereven'kovsky district of the Orel region (Russia) at the experimental plots with usage of serial seeding machine UPS-8 (universal pneumatic seeding machine) with mounted experimental seeding mechanism (figure 3b).

Analysis of the field tests results shows that the suggested mechanism fulfils the majority of standard terms of reference and technical specifications, thereat, serial mechanism does not correspond to some impose requirements on stability and evenness of seeding and also on plant distribution.

Presented in Figure 5 curves of variation of interval distribution between plants in drill rows of corn seeds testify that the suggested mechanism has better seeds distribution than serial one (25,8 % and 19,3 % of plants in the preset interval correspondingly). This is explained in the way that the single selection quality of the suggested mechanism is higher.

Low location of the point in the limit of 0…5 sm on the variation curve of plant distribution of the suggested mechanism testifies that double feedings are practically absent, but curve approximation to zero in the limit of 25…30 sm testifies refers to low level of grain losses in seeding. It proves that the suggested seeding mechanism provides the best quality of one-grain seed dispensing.

Thus, the obtained results of the field tests proved validity of theoretical and laboratory experimental research on improvement of technological process of one-grain seeding and created with this research seeding mechanism corresponds to modern requirements specified to seeding machines and provides highly productive corn seeding for ultimate plant population.

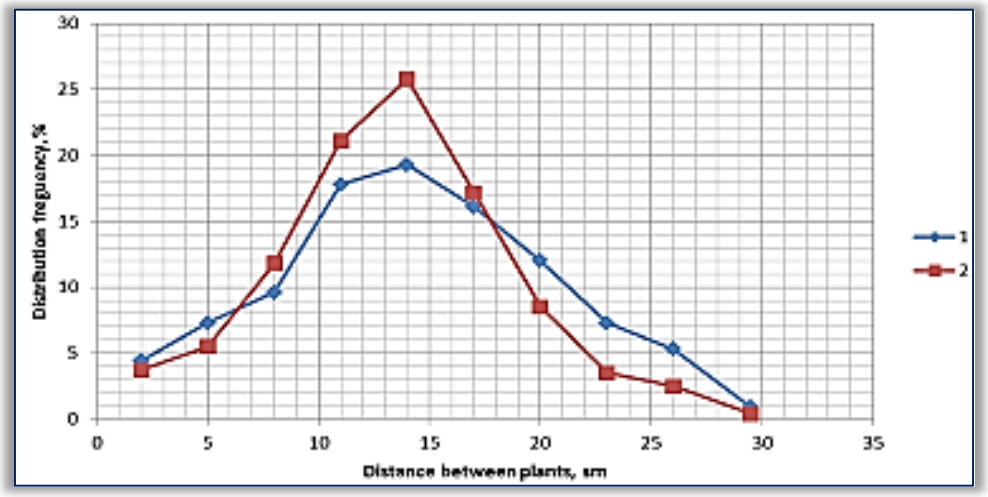

Figure 4 - Variation curve of interval distribution between plants in drill rows of corn seeding done by seeding mechanisms: serial (curve 1); developed (curve 2)

3. CONCLUSIONS

The suggested designs of the seeding mechanism elements provide quality improvement of seed dispensing by pneumatic seeding machines of precision seeding being applied to newly develop seeding machines as well as to already exist and operate in agriculture. It results in obtaining some extra profit with minimum expenditures for machines reequipment.

Note:

This paper is based on the paper presented at ISB-INMA TEH' 2018 International Symposium (Agricultural and Mechanical Engineering), organized by Politehnica University of Bucharest – Faculty of Biotechnical Systems Engineering (ISB), National Institute of Research-Development for Machines and Installations Designed to Agriculture and Food Industry (INMA) Bucharest, The European Society of Agricultural Engineers (EurAgEng), Society of Agricultural Mechanical Engineers from Romania (SIMAR), National Research & Development Institute For Food Bioresources (IBA), University of Agronomic Sciences and Veterinary Medicine Of Bucharest (UASVMB), Research-Development Institute for Plant Protection (ICDPP), Hydraulics and Pneumatics Research Institute (INOE 2000 IHP), National Institute for Research and Development in Environmental Protection (INCDPM), in Bucharest, ROMANIA, between 01–03 November, 2018.

References

[1] Anokhina M.E., Zinchuk G.M., Pravkin I.M. (2016), Conditions of formation of competitive potential of the national Agro Industrial Complex (Условия формирования конкурентного потенциала отечественного АПК), Fundamental investigations (Фундаментальные исследования), Issue number 10, pp. 107-112, Moscow / Russia;

[2] Emelyanov P.A., Ovtov V. A., Matveev D.M. (2016), Underground surface planting of grain crop (Условия формирования конкурентного потенциала отечественного АПК), Agricultural Mechanizator. (Сельский механизатор) Issue number 5, pp.16, Moscow / Russia;

[3] Kalashnikova N.B., Polokhin A. M., Kanunnikov P. P. (2013), Pneumatic dispenser, RF, Patent, No.133678;

[4] Kalashnikova N.B., Polokhin A. M., Kanunnikov P. P. (2013), Improvement of dispenser of pneumatic seeding machine of precision seeding (Усовершенствование высевающего аппарата пневматической сеялки точного высева), Mechanization and Electrification of Agriculture (Механизация и электрификация с/х.) Issue number 3, pp. 4, Moscow / Russia;

[5] Kanunnikov P. P., Kalashnikova N.B., Polokhin A. M. (2013), Development trends of measuring devices of pneumatic seeding machines of precision seeding (Тенденции развития дозирующих устройств пневматических сеялок точного высева), Materials of International research and practice conference (Материалы Международной научно-практической конференции), pp.61-65, Orel / Russia;

[6] Kostikov I. F., Bogapov I. M. (2016), Modernization of share for sorgo seeding in the dry steppe conditions (Модернизация сошника для посева сорго в условиях сухих степей), Young Scientist (Молодой ученый) Issue number 10, pp. 426-430, Kazan'/ Russia;

[7] Kushnarev L.I. (2015), System modernization problems of engineering support of Agro Industrial Complex (Проблемы модернизации системы инженерно-технического обеспечения агропромышленного комплекса), Tractors and Agricultural Machinery (Тракторы и сельхозмашины), Issue number 6. pp. 37-41;

[8] Lachuga Ju.F., Zhuchenko A.A., Ivanov A.L., (2009), Policy of machine and technological modernization of Russian agriculture for the period of 2020 (Стратегия машинно-технологической модернизации сельского хозяйства России на период до 2020 года), Federal State Scientific Institution «Rosinformagrotech». (M: ФГНУ «Росинформагротех»), p. 80, Moscow / Russia;

[9] Sorokin N.T., Soldatova T.G., Lyubchenko V.B., Mitrofanov S.V. (2016), Main factors of growth of agricultural crop yield and its sustainability (Основные факторы повышения урожая сельскохозяйственных культур и его стабильности), Machinery and Equipment for Village (Техника и оборудование для села) Issue number 10. pp. 6-8, Moscow / Russia;

[10] Chernoivanov V.I., Ezhevskiy A.A., Fedorenko V.F. (2012), World tendencies of machine and engineering support of intellectual agriculture (Мировые тенденции машинно-технического обеспечения интеллектуального сельского хозяйства), Federal State Scientific Institution «Rosinformagrotech». (M: ФГНУ «Росинформагротех»), p. 283, Moscow / Russia.

ISSN 1584 - 2665 (printed version); ISSN 2601 - 2332 (online); ISSN-L 1584 - 2665