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Research of Mineral Fertilizers Distribution at KVU-12 Unit Operation at Different Working Modes

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***Abstract*— This article discusses the preconditions for improving the process of mineral fertilizing. When cultivating crops for agricultural purposes, there is a need to mineral fertilizing. Data of practical researches which were carried out in the soil box of the Department of Agricultural Engineering of the Faculty of Technical Service in the agro-industrial complex at Federal State Budgetary Educational Institution of Higher Education "Omsk State Agrarian University". The obtained experimental data are tabulated, and on the basis of them the optimal adjustments for the working elementy of the KVU-12 unit are selected. Because of these adjustments, it is possible to reduce the probability of soil sticking, as well as nozzle blocking when mineral fertilization is applied.**

Keywords—mineral fertilizers, application technologies, unit for mineral fertilizers, distribution of fertilizers during application.

I. Introduction

At the moment, there are a huge number of machines for applying mineral fertilizers [1]. However, most of them are machines for surface or local application. To reduce costs and achieve high crop yields, it is necessary to prepare the soil, namely to apply fertilizer and give time for the necessary level of unlock of its useful properties [2].

One of the most significant ways of yield enhancement of agricultural crops is the use of mineral fertilizers. To improve the process of agricultural production, as well as to ensure sufficient supply of the root system of plants with nutrients, it is necessary to apply spotting of mineral fertilizers [3]. Practical experience and scientific knowledge in the field of mineral fertilizers application are used to promote economic efficiency in the production [4]. At the same time, scientific knowledge cannot be considered outside the production system, since it is an integral part. Compliance with the established dosages, as well as agrotechnical terms, refers to the main factors that must be taken into account when applying mineral fertilizers [5].

Depending on the mineral fertilizers positioning in the soil, the methods of their application are divided into local and continuous, which in turn can be surface and subsurface [6]. As practice and research shows, the surface method of fertilization is used in most activities for the agricultural products cultivation [7]. This method involves the distribution of fertilizers by simple in design working elements of the centrifugal type. However, it has some disadvantages, of which the most significant can be distinguished: uneven fertilizers distribution on the soil surface; transfer of a large amount of fertilizer in the drying soil layer, where it cannot give the desired effect for the root system of plants. When applying mineral fertilizers with heavy harrows and cultivators, up to 70 % of the introduced elements can remain in the soil layer of 0 ... 10 cm. When sealing mineral fertilizers with plows, 50...60% of the introduced elements are placed in the same layer, and only about 20 % of them fall into a layer of 10 ... 20cm. With a lack of moisture, the soil layer 0 ... 10 cm is rapidly subjected to drying out. On the basis of which it can be concluded that more than half of the fertilizers are not available for the root system of plants.

Fertilizers are placed in the soil in continuous or stippled ribbons, with a local method of application. Using this method, it is possible to achieve the optimum ground between fertilizers and seeds. Reducing the energy intensity of works performance can be achieved by presowing application of mineral fertilizers at which all operations are carried out in advance by one unit. Based on the accumulated experimental data, it is possible to point out that mineral fertilizers are better placed under crops and crops of continuous sowing from the point of view of agrochemical efficiency (Fig. 1). Fertilizers should be located in the soil layer 8 ... 15 cm for optimal effect on the seeds. It is also necessary to form a protective layer of 3...7 cm to protect the plant from burns [8].

Based on the literature analysis and according to scientific research [9], local fertilization, compared with scattered, can increase the efficiency of their use up to 20%, while the grain crops yield can increase by 2...5 C / ha. The nutrient utilization coefficient by plants increases by 7 ... 13 %. The combination of local application of fertilizer with soil preparation or soil preparation and planting can greatly reduce the labor intensity. The local fertilization cost is higher than the spread one, but it is worth it, because the effect exceeds the amount of additional costs.

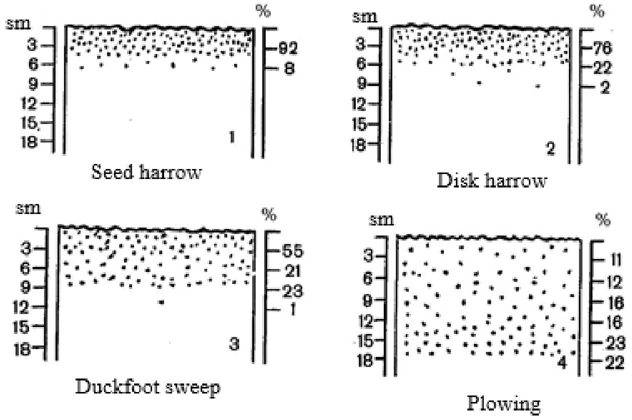

Fig. 1. Mineral fertilizers distribution at different embedding methods.

Many [10] use a spread fertilization method followed by harrowing, cultivation or plowing. As far as is known, the soil upper layers may dry out, and for mineral fertilizers a necessary condition is the moisture presence. That is why the most effective is plowing after spreading. However, given the number of operations performed and the small productivity when plowing, this process is very expensive. As a consequence, you need units that can perform multiple operations in one passage and have sufficient width to minimize processing expenses.

II. Methods

On the basis of the presented scheme (Fig. 2) uniformity calculations of mineral fertilizers application were made. For the purpose, a fixed field area has been selected $S = L \cdot B_{об}$.

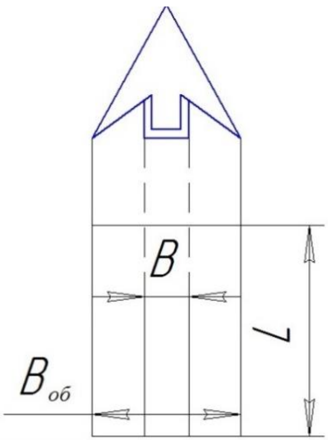

Fig. 2. Pattern of calculation: L – applying length, B– fertilizing width, $B_{об}$ – width of soil preparation by cultivating tine.

Methods of observations are used as the main methods of research directly in the conditions of soil cultivation, data from literary sources with an assessment of the work of cultivators, as well as data from laboratory studies. The study object is the continuous fertilizers application to a given depth with simultaneous cultivation. In the course of the study, the work of the tips of "boots" sprayers of different shapes was compared to identify the optimal adjustments. Practical researches were carried out in the soil box of the Department of Agricultural Engineering of the faculty of Technical Service in the agro-industrial complex at Federal State Budgetary Educational Institution of Higher Education “Omsk State Agrarian University”.

The solution to this problem can be deep cultivation with simultaneous continuous fertilizers application to a depth of 15 cm. This allows reducing the number of operations performed, increase productivityas well as the effectiveness of the fertilizers on the plants' and, accordingly, increase crop yields.

During the research, several spray tips samples to the cultivator were developed for simultaneous continuous fertilizers application to a depth of 13-15 cm (Fig. 3). During the tests carried out in the soil box, the optimal geometry and type of performance of the boot was chosen.

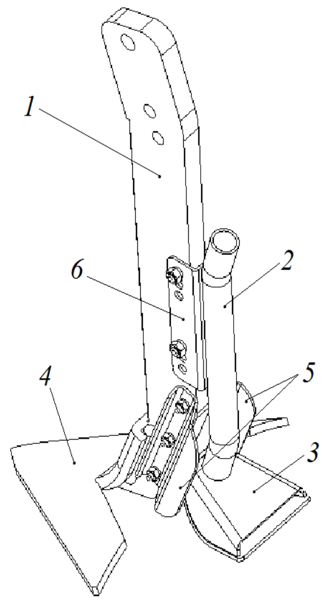

Fig. 3. Cultivator working element which is being studied: 1-ROK pole, 2-iron fertilizer hose, 3- nosepiece, 4-KPE tine, 5- protecting screens, 6-fastening of iron fertilizer hose.

The boots were alternately connected to the cultivator stand for test operatione (Fig. 4). The numbers correspond to the sequence number when conducting practical research. The boot we study has the sequence number 1.

Fig. 4. Boots for continuous fertilization.

III. Results

Practical researches were carried out in the soil box of the Department of Agricultural Engineering of the Faculty of Technical Service in the agro-industrial complex at Federal

State Budgetary Educational Institution of Higher Education “Omsk State Agrarian University”. On the basis of the obtained data, table 1 was compiled, where 1,2 and 3 are the serial numbers of the tips of the boots sprayers (Fig. 4). Tests were carried out in the unit with MTZ-80 tractor.

TABLE I. INDICATORS OF DISTRIBUTION UNIFORMITY OF FERTILIZERS DEPENDING ON MOVEMENT SPEED OF THE UNIT AT EXPERIMENTAL RESEARCHES (IN BRACKETS NUMBERS OF TRANSFERS ARE SPECIFIED)

1		2		3	
4,26 (II)	23	4,26 (II)	17	4,26 (II)	27
7,24 (III)	27	7,24 (III)	22	7,24 (III)	28
8,9 (IV)	28	8,9 (IV)	24	8,9 (IV)	26
10,54 (V)	25	10,54 (V)	22	10,54 (V)	20

On the data basis of table 1 the graph of distribution dependence of mineral fertilizers on the processing area on movement speed of the unit is constructed (Fig. 5).

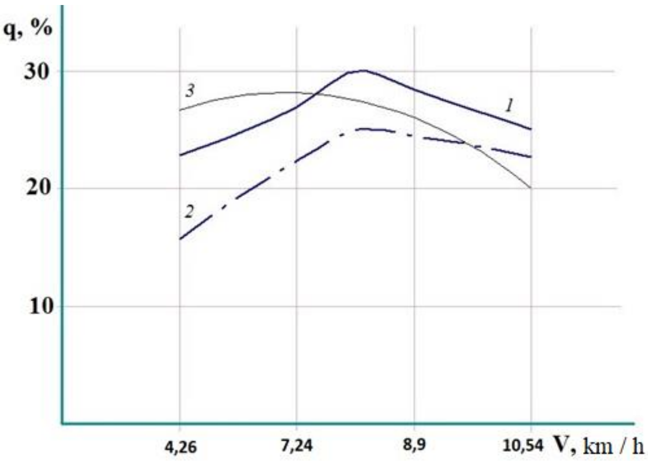

Fig. 5. Dependences of distribution uniformity of fertilizers on movement speed of the unit.

Boot 1 has a peak of distribution uniformity at a speed of 8 km/h, which corresponds to the recommended agrotechnical requirements rate of mineral fertilizers application. Also, when tested, this sample showed high resistance to clogging while applying fertilizers.

Boot 2 at speeds up to 8 km / h has a high tendency to clogging, resulting in low rates of distribution uniformity of mineral fertilizers. The maximum distribution uniformity of 24% corresponds to the speed of the unit 8 ... 9 km / h.

Boot 3 - peak distribution of fertilizers is within the speed of 5 ... 7.5 km / h. Within the speed of 7.5...8 km / h these indicators begin to decrease. And beyond there is clogging connected with increasing speed.

IV. CONCLUSION

As a result of researches 4 forms of boots with different geometry for fertilizers application on the set depth are analyzed. The data obtained as a result of the tests allowed choosing the optimal adjustments of the working element for fertilization. The tested working element meets the agrotechnical requirements and allows reducing soil sticking, as well as clogging of the nozzle when applying fertilizers. Within the optimal rate of mineral fertilizers application 7.5...8.5 km / h has the best indicators of distribution of mineral fertilizers over the processing area (up to 30 %). On the basis of the obtained data, it can be concluded that the investigated working element for mineral fertilizers applying is a promising development and requires additional research in real live operation.

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