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Technical And Operational Indicators And Performance Of The Work Of An Aggregate During The Plowing

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ABSTRACT: The soil should have a cloddy state suitable for seeding and supporting the thrusts of seedlings in order to have a well prepared seed bed. The classic method using the plow is expensive and the quality of work is less where, the need to move towards new technologies is necessary. The discs harrow BPD – 4.2 and tractor K-701 served as technical equipment. The technological operation consists to do the primary tillage in two passages of the aggregate. The tests were conducted in an experimental field of the institute of Agricultural Research of Kirovograd (Ukraine). Site settings and indicators of the quality of work were determined. After the second passage of the machine, the undulation decreased by 58 % and amounted to 1.95 cm, the cloddy state of soil also decreased significantly (during the first passage, the particles having a diameter exceeding 100 mm represents 29 % while in the second passage they represent only 1 %). The total fuel consumption for the two passages is 12.75 l/ha where a reduction of 8.93 % compared to the old technology.
Keywords: discs harrow BPD-4.2, aggregate, indicator, stubble, tillage, performance.

INTRODUCTION

In agriculture, the cultivation occupies a prominent place in scientific research. It is particularly important in modern conditions when the support in technical and agricultural resource empires (Savranchuk V.V. et al, 2005; Gaidenko O.N., 2012; Gaidenko O.N. et al, 2005). Scientific research and the practice of agriculture showed that the intensive cultivation of the soil and the use of materials which soil inversion lead to the deterioration of basic properties of the soil and increase the energy consumption per unit production (Salo V.M. et al, 2011). Thus, a soil preparation using a plow in a first passage and the second passage ordinary disc harrow has an average fuel consumption 14 l/ha an mean undulation of soil 2.35 cm and particles having a diameter exceeding 100 mm representing 3 %. One of the solutions to this problem is to elaborate and implement methods of minimum tillage (Sinyavin, 2003).

The tillage is one of the technological operations that consumes the most energy. It represents about 30 % of energy consumption in extensive technologies (Marchenko V.V., 2009; Popov S. I., 2001). The constant increase in the cost of technology and energy resources has led to the enhancement of the costs of agricultural products. Reducing these costs can be achieved through the introduction of technologies in economical resources and at development of rational utilization forms of the technic (UNIIMESKH, 1985).

The purpose of the research is to reduce the cost of agricultural production through the use of a complex agricultural machinery high productivity and their rational use in agriculture.

The task of research is the choice of lower-cost technologies, the definition of technological systems machinery for their implementation, technical and operational indicators of the aggregate and rational ways of using them.

MATERIALS AND METHODS

MATERIALS

To carry out the study, it was used an aggregate (Figure 1) consist of:
Tractor K701 with a power of 300 hp and

Disc harrow BPD-4.2 with a working width of 4.2 m.
For the execution of necessary calculations, the following materials were used:
A furnace for drying the ground;
A rule for measuring the height of the stubble residues on the surface;
A screen classifier for determining the cloddy state of soil.

Figure1. Aggregate in work, Kirovograd, 2010

METHODS

Production testing of the aggregate was conducted in an experimental field of the Agricultural Research Institute of Kirovograd (Ukraine). Soil characteristics and agro-technical characteristics of each plot were recorded on the list of comments.

During the test, plots were chosen with the same basic settings. The work of the aggregate on these plots was carried out with a system ensuring maximum productivity of the unit in accordance with the agro-technical requirements.

The determination of humidity content and soil hardness were conducted in accordance with the state standard GOST 20915-75, “Agricultural machinery. Methods for determination of the test conditions”. Soil humidity was determined by method “thermo-weight”. For this, the auger was down to a certain depth and the suspension removed from a weight of 30 to 40 g was placed in augers sealed with lids. The number of repetition is 3. The numbers of nerds were registered on the list of comments. Sampling was done at the deepness of working machine in 5 cm apart. The samples were dried in a furnace for 8 hours at 105 ^{0}C. And after cooling, the soil has been weighed and humidity was determined by using the following formula (Gritsishin, 1992):

W = (a/b) x 100 %, (a)

Where a – the weight of evaporated water (weight difference of the auger containing the soil before and after drying), g; b – absolute weight of dry soil, g.

Soil hardness was determined at the same locations where soil sampling was carried out for humidity using the apparatus ‘’Reviakina”. Thus, the following formula was used to calculate that hardness:

P = (hmoy.g)/s, kgf/cm^2, (b)

Where hmoy – average orderly pattern hardness, cm g – spring scale, kgf/ cm; s – sectional area of the plunger, cm^2.

The average orderly was calculated by the following formula:

Hmoy = F/L, cm, (c)

Where F – diagram surface, cm^2, L – Length of diagram cm.

According to the state standard 70.4.1-80, quality machine work tillage was evaluated according to the following parameters (Gosagroprom, 1990; Kukta et al., 1992):

The depth of the worked layer;
The undulation of the ground surface;
The cloddy soil conditions

The plowing depth was determined by the depression of the rule in the ground till the unworked layer. To this end, each repetition of the experiment was carried out not less than five measurements. The measurements were performed at regular intervals across the width of passage and working direction of the unit. The experiment was repeated three (3) times. The average values of the depth of tillage were obtained after processing the data.

The undulation in the field area was determined by measuring the height of the soil crest. After the passage of the aggregate in the direction of the working width, at each repetition, ten (10) measurements were performed at intervals of 10 cm. The measurements were made with an error of ± 1.00 cm and repeated three (3) times. When processing of the measurement results, the average height of the crest was determined.
The condition of the soil was determined by sieving with a sieve classifier. At the end, at each repetition of the experiment, the screening and definition of a value of the proportion of each fraction of the soil by the weight method were proceeded. The measurements were performed according to the passage width and direction of the work unit (machine). The experiment was repeated three (3) times.

RESULTS AND DISCUSSION

RESULTS

The work of the aggregate was tested in a field (Fig.2) with stubble.
The soil is ordinary chernozem type, deep and heavy. The results of the cloddy state of the sol during the first

Figure2. Uncultivated field, Kirovograd, 2010

passage showed that the fractions which have a diameter superior to 100 mm represent 29 %, those which the diameter is between 30 mm and 100 mm represent 20 % and of which the diameter is less than 30 mm are 51 %. But, during the second passage the fractions having which the diameter is greater than 100 mm represent only 1%, those which the diameter is between 30 mm and 100 mm are 29 % and those the diameter is less than 30 mm represent 70 %. The speeds of working of the aggregate for the first and second passage are respectively 9 and 10 km/h. Figures 3 & 4 and Tables 1 & 2 show the results of the cloddy state of soil.

Figure 3. Field cultivated (after one passage of the aggregate), Kirovograd, 2010.

Figure 4. Field cultivated (after two passages of the aggregate), Kirovograd, 2010.

Table 1 . Cloddy state of soil after one passage of the machine:

Hf (mm)	Mv (кg)	Fp (%)
Superior to 100	3.67	29
Superior to 50	1.50	8
Superior to 40	0.37	5
Superior to 30	0.56	7
Superior to 20	0.76	6
Superior to 10	1.10	9
Inferior to 10	4.47	36
Total	12.43	100

Hf =Height of fractions; Mv = Mean values of weight fractions; Fp = Fractions percentage

Table 2 . Cloddy state of soil after two passages of the machine

Hf (mm)	Mv (Kg)	Fp (%)
Superior to100	0.10	1
Superior to 50	2.10	17
Superior to 40	0.80	6
Superior to 30	0.80	6
Superior to 20	1.60	13
Superior to 10	2.20	17
Inferior to 10	5.10	40
Total	12.70	100

Hf = Height of fractions; Mv = Mean values of weight fractions; Fp = Fractions percentage

For the layer located between 0 and 5 cm, the average value of soil humidity was 3.70 %; for the layer between 5 to 10 cm of deepness it is 5.80 %; for the layer between 10-15 cm it is 6.20 %; for which between 15 to 20 cm it is 4.80 %. The table 3 shows the soil humidity.

Table 3. Humidity of soil

Ts (cm)	Wa (g)	Wew (g)	Wds (g)	Hs (cm)	Mv (%)
	32.30	3.40	35.70	4.8	
0.00-5.00	34.00	2.60	39.40	3.4	3.70
	21.40	1.80	39.00	2.9	
	32.00	1.80	21.70	3.2	
5.10-10.00	26.90	6.50	39.20	8.9	5.80
	33.30	4.70	51.60	5.2	
	21.60	7.40	40.90	6.6	
10,10-15.00	19.60	4.70	46.60	6.6	6.20
	29.40	3.70	36.90	5.3	
	26.20	3.30	65.60	3.4	
15.10-20.00	30.30	5.40	49.70	6.3	4.80
	32.70	3.20	33.20	4.6	

Ts=thickness of soil, Wa=Weight of the auger, Wew=Weight of evaporated water, Wds=Weight of dry sol, Hs=Humidity of soil, Mv= Mean values

Table 4. Hardness of soil

Dst (cm)	Mv (kg.cm^{-2})
5	9.00
10	15.80
15	24.90
20	28.90
25	30.60

Dst =Deepness of the sample taking, Mv =Mean value of soil hardness.

The mean deepness of working is 18.40 cm (table 5).

The results of calculations for determining the hardness of the soil have given the following mean values: For the layer between 0-5 cm the hardness is 9 $kg.cm^{-2}$, for which between 5 to 10 cm is 15.80 $kg.cm^{-2}$, for the layer of 10 to 15 cm is 24.90 $kg.cm^{-2}$; and the layer between 15 to 20 cm is 28.90 $kg.cm^{-2}$. The results of the determination of soil hardness are illustrated in Table 4.

Table 5. Deepness of the worked soil

M	R		
	I	II	III
1	180	190	200
2	190	230	170
3	185	170	170
4	215	180	165
5	195	200	170
Tv (mm)	965	920	850
Mv (mm)	193	184	175
Mve (mm)		184	

M= Measurements, R =Repetitions, Dw = Deepness of work, Tv = Total values, Mv= Mean values, Ave = Mean value of the experiment

During the first passage, the mean undulation soil is 33.66 cm, while in the second passage is 19.50 cm (tables 6 and 7).

Table 6. Undulation of the soil (after the first passage of the aggregate)

M	Hc (mm) R		
	I	II	III
1	30	30	32
2	30	37	20
3	28	40	28
4	36	30	41
5	45	32	39
6	30	40	30
7	30	43	47
8	30	25	30
9	20	33	29
10	50	45	30
Tv	319	355	336
Mv	31.90	35.50	33.60
Mve			33.66

M= Measurements, Hc= Height of the crest, R= Repetitions, Tv= Total values, Av= Mean values, Ave= Mean value of the experiments.

Table 7. Undulation of the soil (after the second passage of the aggregate)

M	Hc (mm) R		
	I	II	III
1	8	15	10
2	15	22	23
3	20	22	21
4	23	15	25
5	20	22	18
6	24	10	15
7	14	18	20
8	29	24	23
9	26	15	28
10	15	25	20
Tv	194	188	203
Mv	19.40	18.80	20.30
Mve			19.50

M= Measurements, Hc= Height of the crest, R= Repetitions, Tv= Total values, Mv= Mean values, Ave= Mean value of the experiments.

The results of observations show respectively in the first and second passage a work performance of 1.95 and 2.10 ha/h and fuel consumption 6.80 and 5.95 l/ha. Thus, the total fuel consumption for the two passages is 12.75 l/ha.

DISCUSSIONS

The assessment indicators of the quality of tillage during the second passage are better than those of the first one.

After the first passage of aggregate, the undulation of the worked soil is 3.36 cm and the work deepness is 18.40 cm. After the second passage of the machine, the undulation decreased to 58 % and increased to 1.95 cm; the worked layer of soil (Fig.3) consists of 29 % of particles having a diameter exceeding 100 mm and 15 % of particles with a diameter inferior to 30 mm, the particles of intermediate size represent 44 %; however after the second passage of machine, the worked layer of soil (Fig.4) consists of 70 % of particles which the diameter does not exceed 30mm, the content of particles that a diameter superior to 100 mm is at least 1 %, the content of others particles is at least 30%. This decrease of the ripple and diameter of the soil particles is explained by the fact that the second passage of the machine has crushing clods, making then the soil surface softer and well leveled.

The fuel consumption during the first passage (6.80 1/ha) is greater than for the second passage (5.95 1/ha) which the total is 12.75 1/ha, while the yield during the first passage (1. 95 ha/h) is inferior than for the second passage (2.10 ha/h).This is explained by the fact that during the first passage the aggregate encounter compacted soil where increased traction which leads to a slightly higher fuel consumption and lower performance. These numbers are better than those of Sinyavin (2003), where the undulation is 2.34 cm against 1.95 cm, the fuel consumption is 14 1/ha against 12.75 l/ha and the particles having a diameter greater 100mm represent 3 % against 1 %.

On the second passage of the machine, under conditions of adequate soil humidity, the work layer of soil at state cloddy have fitted for planting the next crop.

Thus, results of testing the disc harrow for primary tillage prove that the machine has been testing is an effective tool for working the soil without turning the soil, mixing of crop residues and soil preparation for planting.

CONCLUSION

The use of new technologies saving energy with tillage effectively without reversal of land is one of the solutions to overcome the problem related to the cost of agricultural production and soil degradation.

In nowadays, many reflections are conducted at several levels in order to improve the quality of cultivation, to limit the number of passage of farm machinery and remove the reversal of the ground.

It is for this reason the researchers are still interested in more direct seeding although it is not suitable for all soil types in order to limit the mechanical interventions in order to minimize the coasts and time saving, to increase the biological activity of surface, to reduce the leaching of nitrogen, to reduce erosion and the fuel consumption.

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