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The detailed method for determining the structure of winter wheat crops

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The purpose. To apply a detailed method for determining the structure of the winter wheat crop. **Methods.** Field experiment, laboratory weighting method, correlation analysis. The structure of winter wheat crop was analyzed, dividing the stalk samples into groups by grain weight from 0.5 g to 4 g with an interval of 0.5 g, which made it possible to determine the biological heterogeneity of stems by weight. **Results.** Using the method of analysis, large sample populations of winter wheat plants are divided into groups according to the weight of grain from an ear, which made it possible to determine the biological heterogeneity of the stems by weight. In the control variant, the maximum mass of stem with spikes exceeded the minimum by 4.7 times, in the fertilized one — by 8 times. The difference between the options is due to the number of groups (in the control — 6, in the fertilized — 8), as well as the amount of data in the groups. Reliable dependences of the mass of ears with grain, the mass of pure grain per ear, number of grains in an ear and mass of stem and a particularly positive dependence of the mass of one grain on the number of grains in an ear were revealed. In the control variant, 85% of the crop was provided by ears with the productivity of 0.5–2 g with biological yield of 413 g/m2, and in the fertilized version, 82% of the crop was obtained from ears with the productivity of 1-3 g with biological crop of 887 g/m2. The results presented were confirmed in 2017. The dependence of the yield structure on the mass of stem and between individual elements of the structure was revealed, as a result of which the potentialities of the studied culture were shown. The undoubted dependence of grain yield on the mass of mother stem makes specialists take care of its growth and development at all stages of winter wheat organogenesis. **Conclusions.** With an increase in the mass of the stem with an ear, the indicators of elements of the structure of winter wheat crop increase.

Key words: *options, groups, stems, ears, grain, mass, correlation.*
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Winter wheat − the base in Ukraine farming the grain culture with areas sown depending on year 6.4–7.3 mln ha of soil, that provide 50% of the total yield grain cultures. Thanks to ita implementation extensively in the production of modern intense technologies of the cultivation of winter wheat has grown significantly its average yield in recent years. The experience of the best farms shows modern intensive technology is capable to provide further significant growth of winter wheat in all areas soil. Recently, 81.7 and 70.9 c/ha were collected in individual farms of Poltavsky and Kyivsky region accordingly in 1987.

Winter wheat yields averaged 40 c/ha in 1990, however in individual farms of Poltavsky and Kyivsky region received on average 81.7 i 70.9 c/ha, respectively, in 1987. This indicates about high biological potential maximum implementation of which is the main task of farmers [1]. Wheat yield stability is provided by compliance to the rules of use of rotations or proper mineral nutrition [2].

Analysis of recent research and publications. The grain yield is determined by two main parameter basis − the density of the productive stem and mass of grain from the ear, the structure of which depends on many smaller components according to Lihochvor's V. V. textbook [3]. The structure of the yield is determined by samples, each of which should reflect the true state of the plants belives. Yes, four variants options are outlined and fixed on every plot with the size of each not less than 4 m^2, but in our opinion plot sizes can be reduced to 1 m^2 [4].

Samples are taken of two incompatible repetitions of options by the square method the latter method being used when the middlelinees is at least 12.5 cm and selected on 4 lines 50 sm according to Naidin's P.G. textbook [4], at this time as other authors [5-6], advise to select samples of two adjacent lines 83 cm in size 83 sm, area of soil 2500 sm^2.

According to the method of state analysis of sort [7], select three samples on leather of plot of soil on two lines in length 55.6 cm.

The basic elements of the structure of the wheat crop: number of plants per 1 m^2, productive shrubs, the mass of grain in the ear, weight of 1000 grains which is indicated in Savitsky's M. S. textbook [8], but the size of the sampling sites is not indicated to determine the number of productive stems and ears.

Workers of agronomy laboratories simplify work and analyze the average stems. The same size of the elements of the structure of the yield wheat noted in publications even on fertilizer variants [9-11].

The grain yield depends on the crop of the unproductive part – straw according Nosatovsky A. N. [12]. The photosynthesis occurs in leaves, internodes and *ear of stem mathers*, its products are coming from the stem to the grain and make up 98% of dry weight.

The main condition for obtaining high yields there is leaf growth reflecting the flow of winter wheat crop formation [13]. Yield is the grain harvesting from unit area soil, so the question arises what changes affect the growth rate of plants and which stems are best taken for analysis.

Analysis of the productivity components of stemof structure is the answer to that.

Known methods of sampling yield wheat do not specify the role of the stem in the formation of the structure of the crop

The purpose. To apply of detailed method for determining the structure of yields of winter wheat. We have proposed a method for determining the structure of a winter wheat crop, which is given below.

Methods. The object of our research is winter wheat sort Elegia 2012, variants:

1 − control (without fertilizer), 2 − fertilizer $N_{60}P_{30}K_{30}$ y into the soil before sowing of seesds. Soil – black soil typical humus smallly difficult loam in the forest, predecessor – peas.

The essence of our proposed methodology − samples of winter wheat plants

taken together with the roots from the square 0,25 m^2 in duplicate. Before starting determine of the shrubby plants. Weighing of individual stems was carried out

on technical scales by accuracy 0,01 g. Cut the stems over the bush node before weighing.

The sequence is as follows: determine the weight of the whole stem with the ear and the weight of the ear with grain, grain is weighed, count the number of grains.

We recommend that you record the results in the table in the following form:

1	2	3	4	5	6	7	8	9
Plant number	Stem number	The mass of the whole stem,g	The weight of the ear with grain, g	Weight of grain from the ear, g	The number of grains in the ear, p.	Weight of one grain , mg	Weight of straw, g	Some notes

The resulting data sets of different metrics represent large sample sets, grouping is used to analyze them [14].

We recommend that when determining the structure of a wheat crop as a basis, in the process of division into groups, to use the mass of grain from the ear in grams as the most commonly used parameter.

According to this indicator we have identified the following groups: up to 0.50 g, 0.51–1.00 g, 1.01–1.50 g, and further with a grain mass increase of 0.50 g.

Dividing into groups by weight of eared grains makes it possible to replace the chaotic variety of winter wheat stems with an orderly system in which the mass of the stems is stepped from the smallest to the largest according to the groups.

The mass of the whole stem with the ear, the ear with the grain, the grain and the number of grains in the ear are divided into groups, each group determines the number of measurements and the average values of the crop structure.

The average mass of one grain is calculated in the ear in each group as a result of dividing the average mass of the grain by the number of grains in the ear and expressed in mg,it corresponds to a mass of 1000 grains per g, as well as the ratio of straw: grain, grain share in the ear, and expressed in%, and biological yield of wheat grain.

By combining the data of two parallel samples for each variant, the correlation coefficients are determined [14].

Results. In the tablei 1, 2 shows the data for determining the structure of the crop, which is the result of the analysis of all productive stems. The tillering coefficient was 1.2–1.3, the density of productive stem was 418–530 p/m^2.

1. Structure of yield wheat of winter, sort Elegia (control variant)

Parameters	№ sample	up to 0,50	0,51-1,00	1,01-1,50	1,51-2,00	2,01-2,50	2,51-3,00	Sum
Number of measurements, n	1	18	42	29	9	4	1	103
	2	13	50	27	13	2	1	106
Sum of measurements, n.		31	92	56	22	6	2	209
Mass of stems with ears, g	1	16.09	63.82	68.26	28.26	15.32	4.50	
	2	13.45	76.45	62.98	3.,79	7.12	4.52	
The sum of the masses of the stem with ears, g		29.54	140.27	131.84	66.05	22.44	9.02	399.16
The average mass of one stem with an ear, g	–	0.95	1.52	2.35	3.00	3.74	4.51	
The sum of the masses of the ears with grain, g	1	9.91	40.22	47.37	20.02	10.75	3.25	
	2	7.99	47.30	42.55	28.85	5.05	3.26	
The sum of the masses of the ears with grain of two samples, g		17.90	87.52	89.92	48.87	15.80	6.51	266.52
The average mass of the ear with grain, g	–	0.58	0.95	1.61	2.22	2.63	3.26	
The sum of the mass of grain from the ears,g	1	7.17	30.01	37.09	16.24	8.91	2.63	
	2	5,64	35,63	33,09	23.21	4.14	2.70	
The sum of the masses of grain from the ear of two samples, g		12.81	65.64	70.18	39.45	13.05	5.33	206.46
The average mass of grain from the ear, g	–	0.41	0.71	1.25	1.79	2.18	2.67	
The total number of grains in the ear,n	1	272	887	947	382	185	58	
	2	188	1005	837	549	84	58	
The sum of the grains in the ears, n		460	1892	1784	931	269	116	5452
Average number of grains in one ear, n.	–	14.8	20.6	31.9	42.3	44.8	58,.	
The average weight of one grain, mg	–	27.7	34,5	39.2	42.3	48.7	46.0	
The part of groups by weight of grain in the formation of grain yield, %	–	6.2	31.8	34.0	19.1	6.3	2.6	100

The distribution of specimens into groups by mass of grains from indicates the presence of different stems by size.

The groups with ear productivity of 0.5 to 1.5 contained the largest number of stems examined. The average mass of stems in groups increases from left to right, the maximum mass exceeds the minimum by 4.75 times. The growth of the average mass of the stem in groups 2–6 compared to the 1st, in%, the following: 21–25–28–55–60.

According to the average mass of the stems, the mass of the ears with the grain changes, that is, the rate of growth of the mass of ears occurs simultaneously with the rate of mass of stems.

The interval of grain weight by groups is in the range 0.41–2.67 g, the maximum mass exceeds the minimum by 6.5 times, which indicates the possible reserves for increasing the grain yield. The largest total amount of grain was obtained from the ear with a productivity of ear from 0.5 to 2.0 g, their the part in the formation of the crop is 84.9%.

In the table shows with increasing mass of the stem all other indicators of the structure of the crop increase. Increase in the mass of one grain with increasing number of grains in groups by productivity occurs from left to righ.

Information on the variant with the use of fertilizers is presented in table 2 and in the photo.

2. Structure of yield wheat of winter, sort Elegia (control variant $N_{90}P_{60}K_{60}$***)***

Indicators	№ Sample	The distribution of groups by weight of grain from the ear, g								
		0,50	0,51-1,00	1,01-1,50	1,51-2,00	2,01-2,50	2,51-3,00	3,01-3,50	3,51-4,00	Sum
Number of measurements, n	1	5	25	41	23	25	14	3	1	-
	2	8	18	23	32	25	14	8	-	-
Sum of measurements, n		13	43	64	55	50	28	11	1	265
Mass of stems with ears, g	1	4 89	38 58	100.46	65.58	99.16	65.61	15.8	7.00	-
	2	6.55	27.04	51.95	96.87	97.33	63.75	44.72	-	-
The sum of the masses of the stem with ears, g		11.44	65.62	152.41	162.45	196.49	129.36	60.52	7.00	785.29
The average mass of one stem with an ear, g	-	0.88	1.53	2.38	2.95	3.93	4.62	5.50	7.00	-
The sum of the masses of the ears with grain, g	1	2.99	24.99	68.62	49.69	69.38	46.23	11.40	5.11	-
	2	4.25	18,08	35.43	65.68	68.17	45.48	31.50	-	-
The sum of the masses of the ears with grain of two samples, g		7.24	43.07	104.05	115.37	137.55	91.71	42.90	5.11	547.0
The average mass of the ear with grain, g	-	0.56	1.00	1.63	2.10	2.75	3.28	3.90	5,11	-
The sum of the mass of grain from the ears, g	1	3.09	13,90	28.28	56.07	55.91	37.24	9.13	4.20	-
	2	2.71	19.71	54.94	38.43	56.14	37.45	26.23	-	-
The sum of the masses of grain from the ear of two samples, g	-	5.80	33.61	83.22	94.50	112.05	74.69	35.36	4.20	443.43
The average mass of grain from the ear, g	-	0.45	0.78	1.30	1.72	2.24	2.67	3.21	4.20	-
The total number of grains in the ear,n	1	77	561	1385	933	1228	781	171	74	
	2	103	403	714	1287	1152	758	497	-	
The sum of the grains in the ears, n	-	180	964	2099	2220	2380	1539	668	74	10124
Average number of grains in one ear, n.	-	13.8	22.4	32.8	40.4	47.6	55.0	60.7	74	-
The average weight of one grain, mg	-	32.6	34.8	39.6	42.6	47.1	48.5	52.9	56.8	
The part of groups by weight of grain in the formation of grain yield, %	-	1.3	7.6	18.8	21.3	25.3	16.8	8.0	0.9	100

The photo shows the difference in the size of the ears and the number of ears in the ears and increasing the size of the ears from left to right.

The mass of the ear, g	0, 83	1, 27	1, 80	3, 18	3, 54	3, 82	4, 48	5, 18
The mass of grain from one ear, g	0, 69	1, 07	1, 51	2, 12	2, 65	3, 16	3, 64	4, 28
Number of grains from one ear, n	19	24	33	45	54	67	72	84
The mass of 1000 grains, g	37,7	40, 6	45, 9	47, 4	50, 3	50, 2	50, 6	51, 4

An increase in the number of groups up to 8 was found in the fertilized variant (table 2), which is explained by the appearance of ears with a capacity of more than 3.0 g, their number is small, however, they do increase the awareness of the variety's potential.

Under the influence of fertilizers, the number of data in the first two groups (the least productive) was reduced, so in the control variant there were 123 and in the fertilized version only 56.

The difference in weight of stems with ears is significant: on the fertilized variant the sum of the masses of stems with ear productivity up to 1 g was 169 g, in the control variant – up to 77 g, and in the 4-6 groups the control amounted to 229 g, when applying fertilizers – 641 g. There is reason to believe that the yield can be relatively easily increased by increasing the productivity of the ear to 1.5-2.0 g. According to the changes in the groups of sums of masses of stem, the sums of masses of grain also changed.

In the variant without fertilizers from low-yielding spikelets (up to 1.0 g of grain), the amount of grain weight was 78.5 g, and on fertilizer – 39.4 g, this is, lesser involvement of these ears is involved in winter yield wheat crop formation. Significant difference between the amounts of grain from the ears of the 3rd – 6th groups: on the control – 128 g, on the fertilized version – 364.5 g.

Table 3 shows the total changes in the structure of the crop sums the differences in crop structure.

3. Influence of fertilizers on the elements of the yield of wheat of the sort Elegie

Option	Number of productive stems, pcs.	Average mass of stems with ears, g	Average mass of ears with grain, g	Average weight of grain from ears, g	Average mass of 1000 grains, g	Biological grain yield, g/m^2	Straw ratio: grain
Control	418	1,91	1,27	0,99	37,9	412,9	0,93
$N_{90}P_{60}K_{60}$	530	2,96	2,06	1,68	44,0	896,9	0,76

The index stem mass is a leader in elements foundation of the yield of wheat of the sort Elegie. Specialists should create favorable conditions for the growth and development of cereals at all stages of organogenesis.

Both in the control variant and on the fertilizer there is a special phenomenon: as the number of grains in the ear increases, the weight of one grain increases. This dependence is observed in the analysis of 474 studied ear, this reserve for increasing yields under favorable growth conditions needs to be explored more deeply. Similar dependence, though in smaller volumes, is observed in research results [16-21]. But in Natova's Z.,and Smochek's U. Article [22] can be read: «…between the weight of winter wheat grain and the number of grains there is a negative correlation..», «not only the number of ears in the plant, but also the number of ears in the ear correlates well with the mass of 1000 grains». It assertions of these authors leads to a more detailed analysis by applying the correlation method.

In the table 4 shows the correlation relationships between the elements of the yield of wheat of the sort Elegie.

4. The relationship between the elements of the structure of the yield of wheat of the sort Elegie

The elements of structure of the yield of wheat	Variation correlation coefficient, R	
	Control, n=209	$N_{90}P_{60}K_{60}$, n=265
The mass of the whole stem a – the mass of the ear with grain, g	R = 0,96±0,002	R =0,98±0,012
The mass of the whole stem – the mass of grain in the ears, g	R= 0,94±0,002	R = 0,95±0,011
The mass of the whole stem , g – the number of grains in the ears, n number of grains in the ear, pcs	R= 0,91±0,028	R =0,94±0,014
The number of grains in the ear , n – the mass of one grain, mg	R= 0,28±0,066	R = 0,62±0,048

Note: the correlation coefficients are reliable at levels of significance of 0.05 and at 0.01 [13].

Advantages of our detailed method analysis of the structure of wheat yield is as follows:

1. Samples are taken from areas of a certain size.
2. The density of productive stems is determined.
3. The stems are grouped by the mass of grain from the ear.
4. All stems are analyzed by weight.
5. Amplitudes of oscillations of values are revealed.
6. The analysis of the groups shows the variety of stems and their participation in the formation of the yield.
7. The dependence of the mass of 1000 grains on the number of grains in the ear.
8. The dependences of the elements of the structure of the crop on the mass of the stem are determined, which indicates the direction of work to create optimal conditions for its growth.
9. Part of it turns out of formed, filled, and therefore biologically valuable grain is revealed.

Conclusions

Difficult to perform, but the most informative method for determining the structure of a winter wheat yield using large sample totalities is presented.

The role of the stem in the formation of all elements of the structure of winter wheat crop is established. The mass of the stems and large sample totalities of plants-stems are the basis of our research on the analysis of the structure of winter wheat.

This method can be applied for plant analysis only from perspective areas of soil due to the time spent on weighing the stems and their parts. The proposed method can be used on a large scale with sufficient workers.

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