The elements of productivity and their contribution to high level of crop yield (based on spring barley researches)

L M Eroshenko¹, O V Levakova², O V Gladysheva², E V Gureeva², M M Romakhin¹ and I A Dedushev²

¹ Federal Research Center Nemchinovka, 6 Agrochemists Street, village Novoivanovskoe, Odintsovo district, Moscow region, 143026, Russia
² Research Institute of Seed Production and Agricultural Technologies - the branch of the Federal Science Agricultural Engineering Center VIM (All-Russian Research Institute of Agricultural Mechanization), 1 Parkovaya Street, Podvyaz‘e, Ryazan district, Ryazan region, 390502, Russia

E-mail: levakova.olga@bk.ru

Abstract. The analysis of long-term data showed that in various agrometeorological conditions, the average yield of the selected numbers of the competitive test was 6.76 t/ha and varied from 6.15 t/ha for the line 4/3-12h 933 to 7.04 t/ha for the Noble variety. The maximum yield was shown in 2016 in the varieties Znatny, Nadezhny and breeding lines 30/3-12h 983 and 135/2-12h 1068 at the level of 8.91 to 9.52 t/ha. The differences between the samples in terms of the level of crop structure elements were revealed. In the group of high-yielding genotypes, breeding lines 141/1-09 h 746, 135/2-13 h 1068, 4/3-12 h 933 were distinguished, the weight of 1000 grains in which was 1.7-5.6 g higher than the average value. Ranking by the complex of the most important productivity characteristics determined the high breeding value of Yaromir, Nadyozhny, Znatny varieties and lines 30/3-12h 983, 135/2-13h 1068 as a source material for breeding to increase the yield of new varieties.

1. Introduction
The spring barley arouses well-deserved interest from the agricultural industry. According to the statistics, from 2016 to 2019 the percentage of barley in the structure of gross grain harvesting in the Russian Federation has raised from 14.9% to 17.6%. This tendency was caused by the increasing demand for barley on the world market. Taking into consideration the soil and climate conditions, requirements and demand of agricultural suppliers the maintenance of crop yield growth is closely related with creating new kinds of spring barley with higher productivity and resistance to domestic ecological environmental factors [1, 2, 3, 4, 5]. Creating the high-yield crops’ kinds with minimal response to adverse biotic and abiotic stressors is the main criteria of barley breeding efficiency [6]. Along with the characteristics of barley varieties by yield, one of the most important pieces of information is information about the degree of expression of the its productivity structural elements, as well as the levels of communication between them. For the barley culture purposed improving, the signs of productivity are ones that play the greatest role. Those signs of productivity are the most significant from the point of view of the crop yield increasing by the means of breeding. In addition, they must be taken in consideration both in case of selecting the elite plants and in case of selecting...
the pairs for crossbreeding. While creating high-yield genotypes of spring barley, it is quite important to provide such crop structure elements optimal combination as the number of productive stems per unit area, the number of grains per head, the mass of grain per head and the mass of 1000 grains, the manifestation of which is more influenced by the agriclimatic conditions of the growing area. The estimation and variation of those parameters justifies the direction of new varieties selection with a list of signs, which guarantee the increasing potential of high-yield crops of spring barley [7, 8, 9, 10, 11].

The establishment of correlations between the main parameters of productivity determines the influence of the structural elements variability on the barley different kinds yields formation and allows to determine the exact criteria for selecting highly productive genotypes by phenotype in barley breeding [12, 13].

The biometrical analysis of spring barley new kinds and perspective breeding lines, analysis of structures’ investments into forming high-yield crops must be taken into consideration as the most effective ways of selecting the most useful origin material for future adaptation improvements in barley breeding [14, 15, 16, 17, 18].

The main objective of our research is to reveal essential elements of crops’ structure, which influence the productivity of spring barley and their relations in conditions of Central Non-chernozem Zone. To achieve it, we solved several tasks:
- to perform a biometrical analysis of spring barley new kinds and perspective breeding lines;
- to research the correlations between different crops signs and their influence on crops yield.

2. Materials and methods
The researches were carried out on the base of the Institute of Seed Production and Agricultural Technologies – branch of Federal Governmental Budgetary Research Center “Federal Scientific Agricultural and Technical Center VIM” (Ryazan Region) during 2015-2019. The most perspective domestic kinds and breeding lines passed several tests. The soil used on the experimental site was dark gray (heavily loamy forest kind of soil). Agrochemical indicators were: $\text{pH}_{\text{salt-extract}} = 5.25$, $\text{pH}_{\text{hydrolicic}} = 4.92$ (in 100g of soil); humus concentration = 5.3 (calculated according to Turin’s theory); the concentration of movable phosphorus (P$_2$O$_5$) = 340 mg per 1 kg of soil; the concentration of exchangeable Calium = 192 mg per 1 kg of soil (calculated according to Kirsanov’s theory); total amount of Nitrogen = 0.25%; amount of hydrolytic nitrogen = 122.8 mg pr 1 kg of soil. The zoned kind of barley “Yaromir” was used as a comparison standard. The experiments were performed on plots with the area of twelve square meters each and were repeated for four times. The seeding rate is 5.0 million germinating grains per 1 hectare. The standard was seeded through 9 numbers. Stem counts were carried out on fixed sites for seedlings and before harvesting. The structural analysis of sheaves was made according to the Methods of Governmental Variety Testing of Agricultural Crops [19]. The agricultural crop that grew on the experimental site earlier is winter wheat. The preparations for soil and plant care measures met the requirements of the zonal farming systems of the Ryazan region for 2015-2019.

According to hydrothermal coefficient (HTC) classification, as it is one of the determining signs of crops’ productivity, the vegetation period of 2015-2016 might be characterized as relatively wet (HTC = 1.6-1.7); but the period of 2018 was dry (HTC = 0.6); 2017 and 2019 were relatively dry (HTC = 0.9-1.0).

The crop accounting was carried out in a continuous way. The yield of each sample is reduced to the standard humidity (14 %). Mathematical calculations of crop capacity data and structural analysis of sheaves were made on a computer by means of Excel program package.

3. Results and discussion
The result of successful breeding experiments by the culture of barley is the creation of spring barley new kinds, which stably overcome the level of crop yield of other genotypes and which use the bioclimatic potential of the region move effectively.
Different temperatures and water availability of vegetation period during the researches (2015-2019) contributed to the objective assessment of the studied varieties for the formation of grain productivity depending on weather conditions. The analysis of variance confirmed the reliability of the kinds selected advantage during the tests according to the main criteria for evaluating the kind – crops’ yield (LSD0.05 = 0.52-0.88 tons per hectare), and a correlation analysis established a high proportion of the hydrothermal coefficient influence on its value (r = 0.72 ± 0.23). The average crops’ yield of spring barley perspective kinds was about 6.76 tons per hectare and varied from 6.15 tons per hectare (line №4/3-12 h 933) to 7.04 tons per hectare (“Znatny” kind – see Table 1). Maximum crops’ yield was recorded in 2016 – from 8.0 to 9.52 tons per hectare (as in May the precipitation was 68% higher than the long-term average, HTC – 1.7). Genetic potential of “Znatny”, “Nadyoshny” and breeding lines №30/3-12 h 983 and №135/2-12 h 1068 was determined in enabling environment conditions on the level of 8.91, 8.96, 9.19, 9.52 tons per hectare; that level is relatively 0.25, 0.28, 0.51 and 0.84 tons per hectare higher than the average level of crops’ yield for a group of spring barley high-productive genotypes. The minimum crops’ yield was recorded in drought year of 2018 (the level of crops’ yield was only 5.19-6.91 tons per hectare). During the vegetation period the precipitation was only 109 mm or 53.1% of the long-term average values (HTC – 0.6). Despite the lack of natural hydration, the average grain productivity of varieties was 5.46 tons per hectare. But, higher values of the trait that exceed the average grade level of cultivars by 24.9-26.6% were noted in the “Znatny” and “Luboyar” kinds. That fact proves their lower dependence on environmental factors.

Table 1. Barley productive stem crop yield and elements, average (2015-2019).

| Kind/breeding line name | Crops yield, tons per hectare | Amount of stems before harvesting, pcs/m² | Amount of productive stems, pcs/m² | Tillering coefficient | Productivity of plant, g |
|------------------------|-------------------------------|-----------------------------------------|----------------------------------|----------------------|-------------------------|
| Yaromir, comparison standard | 6.86±0.59                     | 331±6.0                                 | 796±63.7                         | 2.4±0.20             | 2.7±0.17                |
| Nadyozhny | 6.95±0.76                     | 359±11.0                                | 826±24.6                         | 2.3±0.10             | 2.5±0.07                |
| Znatny | 7.04±0.53                     | 342±28.1                                | 725±47.8                         | 2.1±0.20             | 2.6±0.24                |
| Raphael | 6.85±0.40                     | 328±16.9                                | 759±56.9                         | 2.3±0.08             | 2.3±0.12                |
| Luboyar | 7.00±0.41                     | 320±15.6                                | 670±28.9                         | 2.1±0.09             | 2.4±0.12                |
| 141/1-0 9h 746 | 6.75±0.71                     | 311±19.9                                | 723±49.6                         | 2.4±0.32             | 2.8±0.50                |
| 4/3-12h 933 | 6.15±0.89                     | 305±13.6                                | 601±30.7                         | 2.0±0.12             | 2.4±0.24                |
| 30/3-12h 983 | 6.64±0.78                     | 339±25.2                                | 885±82.9                         | 2.6±0.28             | 2.8±0.27                |
| 27/3-12h 977 | 6.73±0.64                     | 334±20.2                                | 708±59.5                         | 2.2±0.20             | 2.5±0.26                |
| 181/1-12h 897 | 6.90±0.54                     | 320±15.6                                | 572±29.1                         | 1.8±0.13             | 2.5±0.09                |
| 135/2-13h 1068 | 6.46±0.66                     | 341±11.6                                | 717±15.1                         | 2.1±0.12             | 2.4±0.17                |
| Average | 6.76±0.30                     | 330±4.71                                | 726±27.70                        | 2.2±0.07             | 2.5±0.05                |
| Variation coefficient, Cv, % | 3.7                           | 4.7                                     | 12.6                             | 9.9                  | 6.3                     |
| Correlation coefficient with crops yield | -                              | +0.39±0.31                              | +0.33±0.31                       | +0.13±0.33           | -0.08±0.33              |
| LSD0.05 | 2015 | 0.52                          | 2016 | 0.88                          | 2017 | 0.65                         | 2018 | 0.61                         | 2019 | 0.63                         |
The yield is usually a derivative of two values; they are the productive stem and the productivity of the head. The components of the first derivate are the number of plants before harvesting, the number of productive stems, coefficient of tillering, plant productivity; the second one is determined by the length of a spike, number of grains per a spike, grain weight of a spike and weight of 1000 grains.

The formation of a high yield in spring barley intensive kinds is due to one or another one, but in general, the optimal ratio of plant productivity elements. The yield of about 7 tons per hectare under the same conditions can be formed due to the different correlation levels of the heads number per area, the number of grains per head and the mass of 1000 grains. Thus, the "Znatnyi" kind in the Ryazan region with the yield of 7.04 tons per hectare had only 725 spikes per square meter, average amount of grains per head - 22.8 pieces, weight of 1000 grains - 49.2 g; “Lyuboyar”, respectively, 7 tons per hectare, 670 spikes per square meter, 21.9 pieces, 51.7 g. According to that, we can say, that one of the highest productivity important elements weak development was compensated by other elements. This ability is the most important sign of the spring barley high-yielding kind plasticity.

The indicator that characterizes the spread of values relative to the average level, or the coefficient of variation, showed that such elements of the structure as the length of spike, or the amount in head, the weight of 1000 grains, determined by high-intensive genotypes kinds’ features, were characterized relatively by weak variability (Cv = 4.7-5.9%). Stronger kinds’ differences (Cv = 9.9-12.6%), which appeared during the experiments were marked according to the signs “tillering coefficient” and “amount of productive spikes per square meter”, which correlation is greatly influenced not only by the genotype of kind, but also by the conditions of growth.

One of the most important element of crops yield, which is considered to be the main factor of kind’s plasticity is the indicator of productive stalks density [3, 5, 7]. In average, during 5 years range of sign “amount of productive spikes per square meter” changes from 572 to 885 pcs/m², and if “tillering coefficient” is equal to 2.2, the “amount of productive spikes per square meter” is equal to 726 pcs/m². The best value was obtained in “Nadyozhny” kind (826 pcs/m²) and breeding line № 30/3-12h 983 (885 pcs/m²).

The crops planting density is a very important biological property and an optimal indicator of the genotype adaptive capabilities. In contrast to the stem-forming ability, there were no significant differences between kinds of barley in terms of plant survival (Cv = 4.7%). The low difference in plant safety for harvesting in kinds, which were selected for productivity on different intensity field backgrounds, in the selection plan, implies a directed selection action on the basis of "number of plants before harvesting” (measured in pcs/m²) and characterizes their overall advantage in the adaptability of this trait.

A prerequisite for obtaining high yields is the realization of the crop structure significant element biopotential - the number of grains in the ear. In our research, the average value of the head seeds content index was 21.8 pcs and varied from 20.7 to 24.2 pcs. The highest value of this sign was found in the perspective breeding lines №181/1-12h 897 (24.2 pcs) and №27/3-12 h 977 (22.9 pcs).

The results of correlation analysis allowed to identify the measure of productivity elements influence on forming high spring barley crops yield. We revealed a positive correlation between crops yield and such parameters as “amount of productive stems, pcs/m²” (r = 0.22 ± 0.32), “amount of stems before harvesting, pcs/m²” (r = 0.39 ± 0.31) and “amount of seeds in head, г” (r = 0.39 ± 0.31).

The most important varietal feature and indicator of barley technological properties is grain size indicator, expressed in terms of the mass of 1000 grains. In the conducted researches, the analysis of high-yielding assortment experimental data showed a negative role of increasing the density of the stem on the mass index of 1000 grains. Unfavorable relation between these indicators is reflected in Figure 1 and confirmed by a high negative value of the calculated correlation coefficient (r = -0.74 ± 0.22). At the same time, despite the fairly strong negative correlation between grain productivity and a sign of grain size (r = -0.62 ± 0.26), in the experimental group set of separated lines № 141/1-09h 746, № 135/2-13h-1068, № 4/3-12h 933, the weight of 1000 grains was 1.5-1.6 grams more than average one in the same kind of barley.
No significant relationship was found between the length of the head, the weight of the grain from the head, the productivity of the plant and the yield ($r = -0.18...0.23$). Obviously, in the conditions of the Ryazan region, different kinds of barley with different values of these characteristics can be highly productive. At the same time, there is a fairly close negative relation between the productive stem and the indicators of the grain amount per head, the length and weight of the grain in the head ($r = -0.58...-0.80$). For these relationships that characterize the receiving of a productive stem particular level depending on the variability of the head productivity indicators, the probability varies from 36 to 66.4%.

The limiting factor in the forming barley high-yield crops, especially in conditions of sufficient moisture, is very often the lodging of crops. Spring barley variety resistance to draught is determined by its genotype and in most cases depends on the plants height. As the rule, there is a weak positive relationship between the signs of productivity and the plant height, especially for spring barley. For new kinds and breeding lines that belong to the Western European morphotype and are characterized by the limited stem growth, in our researches the average crops yield did not depend on the height of the plant. The tightness of the relation was characterized by a correlation coefficient of -0.15, that is, only 0.2% of the crops yield variability, and was determined by the variation of the plant height indicator. A resistance to draught further increase should be aimed at creating varieties with a low but strong stem (Table 2).
Table 2. The height of plants and elements of stem’s productivity, average (2015-2019).

| Kind/breeding line | Height of the stem, cm | Length of the head, cm | Amount of seeds in spike, pcs | The weight of seed in the head, g | The weight of 1000 seeds, g |
|---------------------|------------------------|------------------------|-----------------------------|---------------------------------|----------------------------|
| Yaromir, comparison standard | 82.3±4.64 | 7.1±0.47 | 22.2±1.40 | 1.13±0.08 | 48.6±0.64 |
| Nadyozhny | 71.0±5.76 | 6.5±0.19 | 20.7±0.30 | 1.08±0.02 | 48.6±0.79 |
| Znatny | 85.5±5.07 | 7.3±0.53 | 22.8±1.34 | 1.21±0.07 | 49.2±0.87 |
| Raphael | 72.3±5.28 | 7.0±0.36 | 20.9±0.08 | 1.00±0.01 | 46.7±1.06 |
| Luboyar | 82.3±6.60 | 7.5±0.20 | 21.9±0.40 | 1.14±0.03 | 51.7±0.76 |
| 141/1-0 9h 746 | 79.8±6.56 | 7.0±0.31 | 21.2±0.75 | 1.17±0.06 | 52.1±1.69 |
| 4/3-12h 933 | 86.9±5.60 | 7.2±0.30 | 21.2±0.30 | 1.22±0.07 | 56.0±1.31 |
| 30/3-12h 983 | 79.5±5.07 | 6.4±0.25 | 20.9±0.33 | 1.06±0.04 | 47.6±2.02 |
| 27/3-12h 977 | 83.8±5.75 | 7.5±0.23 | 22.9±0.38 | 1.18±0.03 | 49.2±1.53 |
| 181/1-12h 897 | 85.3±7.20 | 7.8±0.59 | 24.2±0.40 | 1.26±0.06 | 51.8±1.59 |
| 135/2-13h 1068 | 76.3±11.30 | 6.7±0.30 | 20.7±0.46 | 1.15±0.06 | 53.7±2.80 |
| Average | 80.5±1.60 | 7.1±0.13 | 21.9±0.34 | 1.15±0.02 | 50.4±0.83 |
| Variation coefficient, Cv, % | 6.6 | 5.9 | 5.2 | 6.1 | 5.6 |
| Correlation with crops yield | -0.15±0.33 | +0.23±0.32 | +0.31±0.32 | -0.18±0.33 | -0.62±0.26 |

In the selection work, which is aimed at increasing the varieties productivity, the forms with high values of structural elements positively associated with crops yield have the greatest donor value, and, despite the inverse dependence of yield on the mass of 1000 grains, as we established in our experiment are large-grain genotypes.

More complete information about the productivity elements spring barley kinds breeding value was obtained by ranking significant indicators based on their integrated complex assessment (Table 3). It is noted that the value of the productivity elements ranks sum is statistically positively related to the values of the average barley’s yield ranks \( r = 0.67±0.25 \). The lowest value of this sum, which characterizes the rating advantage, comparing to other genotypes, were recorded during the experiments with “Yaromir”, ”Nadyozhny”, “Znatny” kinds and breeding lines №30/3-12h 983, №135/2-13h 1068.

The involvement of the competitive kinds’ testing specified numbers in crossbreeding makes possible to obtain transgressions for the set of productivity characteristics and increase the probability of selecting high-yielding kinds from the hybrid combination.
Table 3. Ranking the spring barley perspective kinds average productivity indicators.

| Sort/ breeding line | Amount of stems before harvesting, pcs/m² | Amount of productive stems, pcs/m² | Tilling coefficient | Amount of seeds in the head, pcs | The weight of 1000 seeds, g | Σ of parameters |
|---------------------|-----------------------------------------|---------------------------------|-------------------|---------------------------------|----------------------------|-----------------|
| Yaromir, comparison standard | 6 | 3 | 2 | 4 | 8 | 23 |
| Nadyozhny | 1 | 2 | 4 | 11 | 8 | 26 |
| Znatny | 2 | 6 | 7 | 3 | 6 | 24 |
| Raphael | 6 | 5 | 4 | 9 | 11 | 35 |
| Luboyar | 8 | 4 | 7 | 5 | 5 | 29 |
| 141/1-0 9h 746 | 10 | 7 | 2 | 7 | 3 | 29 |
| 4/3-12 h 933 | 11 | 10 | 10 | 7 | 1 | 39 |
| 30/3-12 h 983 | 4 | 1 | 1 | 9 | 10 | 25 |
| 27/3-12 h 977 | 5 | 9 | 6 | 2 | 6 | 28 |
| 181/1-12h 897 | 8 | 11 | 11 | 1 | 4 | 35 |
| 135/2-13h 1068 | 3 | 8 | 6 | 6 | 2 | 25 |

4. Conclusion

Judging by the samples selection research results, which were chosen during kinds’ competition in conditions of Ryazan region we selected 5 kinds of barley and 6 breeding lines, which exceeded any others by the level of crops yield. “Znatny” kind had the best properties, such as grain productivity (both average among other kinds and in contrast conditions). On the basis of correlation analysis, we stated that barley’s yield depends on several productivity signs: amount of stems before harvesting, amount of productive stems and amount of seeds in the head. The observed high negative correlation between the mass of 1000 grains and the yield \( (r = -0.62 \pm 0.26) \), as well as between the density of the productive stem and the mass of 1000 grains \( (r = -0.74 \pm 0.22) \) does not exclude the possibility of creating large-grain high-yielding kinds of intensive barley. “Yaromir”, “Nadyozhny”, “Znatny” and breeding lines № 30/3-12h 983, № 135/2-13h 1068, which were chosen by the list of productivity signs, were determined as high-yield kinds of barley. Seeds from those kinds and breeding lines have the best breeding characteristics and may be used as a breeding material in future.

References

[1] Robinson L H, Juttner J, Milligan A, Lahnstein J, Eglinton J K and Evans D E 2007 The identification of a barley haze active protein that influences beer haze stability: Cloning and characterization of the barley SE protein as a barley tryps in inhibitor of the chloroform/methanol type J. of Cereal Science 3 343-352

[2] Sarkar B, Ram Sh, Verma R P S and Sarkar A 2014 Identifying superior feed barley genotypes using GGE biplot for diverse environments in India Indian J. of Genetics and Plant Breeding 1(74) 26-33

[3] Anisimova N N and Ionova E V 2016 The structural elements of spring barley yield and their contribution into formation of plants high productivity Grain Economy of Russia 5 40-43

[4] Batasheva B A and Alderov A A 2010 Productivity of cultural barley (Hordeum vulgare L.) in connection with precocity South of Russia: Ecology, Development 1 20-25

[5] Batasheva B A 2010 A new variety of winter barley for the conditions of Dagestan South of Russia: Ecology, Development 1 17-19

[6] Pleskachev Yu N and Borisenko I B 2012 The use of "Ranch" in the use of barley Scientific-Agronomic J. 2 30

[7] Surin N A, Lyakhova N E, Gerasimov S A and Lipshin A G 2018 Evaluation of collection
samples of spring barley in breeding for grain productivity and quality in Eastern Siberia

Achievements of Science and Technology in Agriculture 32(5) 4-44

[8] Kokina L P, Shchekleina L M and Kunilova A V 2017 Sources of selection and valuable traits and their use in creating barley varieties that are adaptive to the conditions of the Volga-Vyatka region Agricultural Science of the Euro-North-East 3(58) 9-14

[9] Radyukevich T N, Bondareva L M and Kartasheva L I 2018 Evaluation of new collection samples of barley on economically valuable characteristics in the conditions of the North-West of Russia Perm Agricultural Bulletin 4(24) 76-82

[10] Drobyshev A V and Taranukho G I 2017 Elements of the winter soft wheat promising varieties yield structure Bulletin of the Belarusian State Agricultural Academy 4 57-60

[11] Konstantinova I N and Vladimirova E S 2019 Source material of spring barley in Yakutia Int. Agricultural J. 5 46-49

[12] Kukushkina L A, Stolpivskaya E V and Vukolov V V 2018 Study of the source material for the selection of spring barley by elements of the crop structure Int. J. of Humanities and Natural Sciences 11(2) 28-33

[13] Sidorenko V S, Naumkin D V, Kostromicheva V A, Starikova Zh V and Ukhova F V 2016 Prospects for breeding naked barley and oats in Central Russia Legumes and Cereals 1(17) 78-83

[14] Borovikov V P and Borovikov I P 1997 Statistica. Statistical Analysis and Data Processing in the Windows Environment (Moskow: Filin)

[15] Levakova O V and Bannikova M I 2019 Screening of winter soft wheat promising varieties by elements of the yield structure and its stability in the conditions of the Non-Chernozem Center region Bulletin of the Agro-Industrial Complex of the Upper Volga Region 1 35-39

[16] Nettevich E D, Smolin V P and Makarov V P 1995 Features of yield formation by different varieties of spring barley in the conditions of the nonchernozem center of Russia The Reports of the RASHN 1 3-5

[17] Eroshenko L M, Eroshenko A N, Romakhin M M and Eroshenko N A 2011 Selection improvement of spring barley for adaptivity in the conditions of the Central non-chernozem region Agrarian Science of the Euro-North-East 5 15-19

[18] Duktova N A and Kuznetsova N A 2019 Evaluation of the spring durum wheat source material for a complex of economically useful traits and selection of sources for breeding Bulletin of the Belarusian State Agricultural Academy 2 142-147

[19] Golovachev V I and Kirillovskaya E V 2019 Methods of State Variety Testing of Agricultural Crops (Moscow)