



Environmental sustainability assessment of cotton varieties of Uzbekistan bred

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Abstract

This article describes a method for processing the results of environmental tests, which allows not only to compare varieties by their average yield, but also to determine their response to changing conditions, assess their potential and select the best varieties for their cultivation in terms of environmental plasticity. The proposed method will make it possible to evaluate cotton varieties by stability in response to changes in cultivation conditions, an assessment of their potential capabilities and selection by their ecological stability (plasticity) in various regions of the Republic of Uzbekistan. The regression coefficients, characterizing the reaction of varieties to changes in the level of yield, turned out to be different, if there is a full correspondence of the yield of a variety to changes in test conditions, the regression coefficient is 1.00. Condition indices varied from point to point by 0.5-4.7 centners / ha. Exactly the same variability is observed in cultivar C -6550, the regression coefficient of this cultivar is 0.9. The yield of "the Khamkor" cotton variety, despite significant fluctuations in the test points, on average changed by 1.3 (bi = 1.3). The yield of the cotton variety UzFA-707 in the test points changed on average by 1.1 (bi = 1.1). It was revealed that the cotton variety C-6545 was more stable in comparison with other studied varieties. Although the yield of this cotton variety is neither maximum nor minimum, it gives a more stable yield.

Keywords: cotton varieties, stability, adaptability, homeostaticity, regression coefficient, environmental conditions

1. Introduction

Uzbekistan is one of the leaders in the global cotton market, ranking sixth in terms of cotton production and fifth in terms of its export. Every year the country grows an average of 3.5-3.7 million tons of raw cotton and produces 1-1.2 million tons of cotton fiber. Uzbek cotton is mainly exported to countries such as China, Russia, Iran, Bangladesh, South Korea, Vietnam. Some of the Uzbek cotton is also purchased by European companies in Germany, Great Britain, Switzerland, Belgium and France. In addition, about three hundred thousand tons of cotton fiber is sold on the local market for textile enterprises, some of whose products also go to the markets of Western countries [7].

In order to ensure the implementation of the Decree of the President of the Republic of Uzbekistan dated October 23, 2019 No.UP-5853 "On approval of the Strategy for the Development of Agriculture of the Republic of Uzbekistan for 2020-2030", including the introduction of market principles that ensure free competition in agriculture, the cancellation of state orders for the production of cotton and grain, increasing the economic efficiency of production and the interest of product manufacturers, creating additional jobs due to the wide attraction of investments

The Law of the Republic of Uzbekistan of August 29, 2002 "On Breeding Achievements" states that plant varieties must have high uniformity and stability in terms of morpho-economic characteristics.

To date, in recent years, the Center for Crop Variety Testing of the Ministry of Agriculture of the Republic of Uzbekistan has tested and zoned a number of cotton varieties created in various genetic-selection institutions of the country.

When carrying out breeding work in the population of a future variety, breeders select the best plants with the least manifestation of low indicators of quantitative traits. At the

same time, much attention is paid to the manifestation of such properties as stability (plasticity), homeostaticity, the ability to withstand various environmental factors of the environment. In view of their high importance, these properties, along with indicators of economically valuable traits, should be used in a comparative assessment of the tested and cultivated cotton varieties [3].

The ecological conditions of growing cotton cause a versatile variability of its characteristics and properties, which is not fixed in the offspring, that is, it is modification or paratypical. Modification variability can be caused by many reasons: unevenness of soil fertility, differences in macro- and microrelief, violations of agrotechnical measures during sowing and during the growing season, changes in weather and climatic conditions. These reasons lead to an increase in the environmental or paratypical variability (dispersion) of the population. The variability of the population is caused by the different competitiveness of plants even on leveled agricultural backgrounds. For example, with a rapid initial growth associated with high sowing qualities of seeds, plants occupy a large area of nutrition, worsening the nutritional conditions of neighboring plants [8, 9].

However, some varieties during the testing period, after being recognized as promising or zoning, were withdrawn from testing and production in a short period of time due to the deterioration of their economically valuable indicators, including a decrease in yield compared to varieties more adapted to specific environmental conditions.... This picture is observed at the present time. At the same time, it should be noted that cotton variety 108-F was sown for more than 50 years and the sown area under this variety reached up to 1 million hectares, and varieties C-4727, AN-Bayaut-2, C-6524, Bukhara-6 are sown for more than 25 -30 years and remain in demand to this day [4].

Extensive geographic trials of new varieties show their unequal ecological stability. Some varieties produce more stable yields, while others are highly responsive to changing growing conditions. This shows that plant varieties have different reaction rates (homeostaticity), i.e. different breadth of possible adaptive characteristics to varying environmental factors [6].

For the first time in the republic, an analysis of the research results was carried out by A.A. Narimanov and N. Gaibullaev (2006), which showed that most of the tested new cotton varieties were significantly inferior in yield to the zoned cotton varieties more adapted to soil and climatic conditions. This indicates the importance of assessing the stability indicator in terms of yield and other economically valuable traits in new cotton varieties before the stage of their zoning.

When carrying out genetic selection studies and obtaining new genotypes, as a rule, the task is to identify forms that combine a complex of economically valuable traits, and the question of a variety's fitness, its adaptive capabilities, responsiveness to environmental conditions and stability remains open [1].

The economic feasibility of the cultivation of agrochemically promising varieties (APS) of wheat, barley, soybeans, potatoes, peas has been proven [2].

Genetic methods for assessing the prospects of agricultural plants still have an insufficient share in genetic selection studies, especially on cotton crops. Success or failure in cultivating cotton varieties and obtaining maximum yields depends entirely on the introduction of potentially productive varieties capable of producing an optimum yield at a minimum cost, i.e. varieties must be stable to growing conditions [4].

Taking into account the different ecological conditions of the Republic of Uzbekistan, it becomes necessary to use assessments of the ecological responsiveness and stability of new varieties of cotton, created by breeders of our Republic. At present, although the homeostaticity parameter exists, it is little used in science and is not sufficiently implemented in agricultural production. This parameter is important along with the main economically valuable traits, because the realization of genotypic capabilities depends entirely on the characteristics of the genotype, the ability to withstand various unfavorable environmental factors. Evaluation of varieties for their ecological stability (plasticity) and responsiveness to environmental conditions is of great interest for theoretical research and is very important for practical breeding [5].

The rate of reaction of the genotype to environmental conditions is different and depends on the ability of each organism to adapt to the environment due to changes in this reaction. In this regard, it becomes necessary to calculate the parameters of responsiveness to environmental conditions and crop stability using the mathematical model of Eberhart and Russell (1966, 1969), to evaluate the stability parameters by two indicators - the regression coefficient and the standard deviation (variant) from the regression line [10].

2. Materials and methods

The experiments were laid according to the methodology of the State Commission for Variety Testing of Agricultural Crops

of the Republic of Uzbekistan (2010), in four replicates according to the generally accepted agricultural technology in farms.

In our studies, five regions of Uzbekistan were selected, where promising medium-fiber varieties of cotton were studied: C-6545, C-6550, UzFA 707, UzFA 710, "the Khamkor" variety was taken as the standard.

According to the test results, the reaction of varieties to changes in soil and climatic conditions, an assessment of their potential capabilities and the selection of varieties for their ecological stability (plasticity) in different regions of the republic were determined.

For statistical analysis, all the results of the geographic test are summarized in a matrix v, n , where v is the number of varieties tested and n is the number of test points.

When calculating stability parameters, the following model is used:

$$i=1,2,\dots, v$$

$$X_{ij} = X_i + b_i l_j + d_{ij} \quad j = 1,2,\dots, n, \quad (1)$$

where: X_{ij} – harvest of the i -th variety at the j -th point; X_i – average yield of the i -th variety for all test items; B_i – regression coefficient of the i -th grade for changes in conditions; l_j – index of environmental conditions in the j -th point; d_{ij} – deviation from the regression lines of the i -th grade at the j -th point.

To characterize the variety of test conditions, the environmental condition indices are calculated.

$$j = \frac{\sum x_{ij}/v - \sum i \sum x_{ij}/vn}{\sum i^2} \quad (2)$$

Using the indices of environmental conditions, the regression coefficients of the yields of each variety are calculated for changes in conditions:

$$(b_i = \frac{\sum l_j x_{ij}}{\sum l_j^2}) \quad (3)$$

These coefficients show the responsiveness of varieties to changing conditions.

The higher the numerical value of the regression coefficient, the more the variety's yield changes under different conditions. In most cases, the coefficient has a positive sign, since with the improvement of growing conditions, the yield, as a rule, increases. However, in some cases, negative values can be obtained (for example, with an increase in the yield level, a certain variance turned out to be prone to lodging, which can cause a decrease in its yield under favorable test conditions). The scatter of yields is characterized by the standard deviation (S_{2d}) of yields of each variety from its regression line. The calculation of this option is done in several stages. First, the theoretical yields of each i -th variety at each j -th point are calculated:

$$IX_{ij} = X_i + b_i l_j \quad (4)$$

The next step is to determine the deviations of theoretical yields from actual ones for each i -th variety at each j -th point:

$$d_{ij} = X_{ij} - IX_{ij} \quad (5)$$

After that, it is easy to obtain an approximate variance of yield stability for each variety.

$$S2di = \sum_j d2ij / (n-2) \quad (6)$$

To obtain a more accurate value of this variance, it should be reduced by the generalized error of experiments:

$S2di = \sum_j d2ij / (n-2) - S2e / r$, where $S2e$ - is the weighted average variance of standard deviations of errors at each j - th point, r - number of replicates in variety trials.

The regression line will make it possible not only to compare varieties by their average yield, but also to determine their reaction to changing conditions, assess their potential and select varieties for cultivation at certain yield levels, compare them in terms of their ecological plasticity and distinguish the most stable varieties from new varieties under different conditions of environment.

3. Results and Discussion

The results obtained will make it possible to solve questions about the prospects of this or that variety in certain regions of cotton growing in the Republic of Uzbekistan, and appropriate recommendations will be given.

The data on the yield of the studied four varieties of cotton with "the Khamkor" standard in five plots of state variety testing and calculations of stability parameters are shown in Table 1 (table 1).

First of all, we determined the calculation of the indices of environmental conditions by the formula (2). The environmental condition indices represent the deviation of the average yield from the average yield of all varieties at each location. The condition indices show how much worse or better the growing conditions at each test point in comparison with the average conditions of the entire experiment. Thus, the sum of all indices must be zero, i.e. which can serve as a control of the correctness of calculations. According to the table, the indices of environmental conditions show that in this experiment there are sufficient differences in the level of yield: the average yield at different points of the test ranged from 27.7 to 41.6 centners/ha, and the indices of conditions - from 6.4 to 7.5 centners/ha. Depending on the task, it is necessary to select such test conditions that would correspond to the objectives of the study. For example, if the goal is to determine the theoretical homeostasis of the studied varieties, then the more varied the yield level in individual test points, the more accurately the studied trait can be determined. In the

case when the practical task of identifying the variety that is most suitable for certain cultivation conditions is being solved, then the test conditions should correspond to the most typical for the given area and should reflect all possible variability in the proposed range of distribution of the variety.

The next step is using the indices of environmental conditions to calculate the regression coefficients of the yields of each variety for changing conditions according to formula (3). The regression coefficients, characterizing the reaction of varieties to changes in the level of yield, turned out to be different. In the case when there is full compliance with the yield of the variety to the change in test conditions, the regression coefficient is 1.0. The condition indices in this experiment varied from point to point by 0.5-4.7 centners / ha. Exactly the same variability is observed in cultivar C -6550, the regression coefficient of this cultivar is 0.9. The yield of "the Khamkor" cotton variety, despite significant fluctuations in the test points, on average changed by 1.3 ($b_i = 1.3$). The yield of the cotton variety UzFA-707 according to the test points, on average, changed by 1.1 ($b_i = 1.1$).

In Figures 1 and 2 (figures 1 and 2), in order, the average yield of varieties for changing conditions is presented. Also, the actual yields, regression lines and stability options for varieties C-6550 and UzFA-707.

The main parameter for the study of ecological stability (plasticity) are indicators of the yield of cotton varieties in different environmental conditions. Based on the research carried out, it is planned to summarize and draw conclusions about the advisability of using the parameters of ecological stability (plasticity) on cotton and its prospects for this crop. Carrying out such a study using the mathematical model of Eberhart and Russell (1966, 1969) will undoubtedly make it possible to more accurately identify new cotton varieties at an early stage of their study. At the same time, it will be possible to supplement the existing methodology of the State Center for Variety Testing of Agricultural Crops with a new section on studying the stability of cotton varieties in competitive trials. The method we use for processing the results of environmental tests allows us not only to compare varieties by their average yield, but also to determine their response to changing conditions, assess their potential and select varieties for their cultivation, compare them in terms of environmental plasticity, and identify varieties that are most stable in different environmental conditions.

4. Tables and Figures

Table 1: Raw cotton yield in cotton varieties and stability parameters

Varieties	Karshi	Shakhrikhon	Pskent	Chimbay	Ok-oltin	xi	xi	Parameter stability	
								bi	S2di
St "the Hamkor"	38,4	46,5	27,3	23,4	32,5	168,1	33,6	1,3	16,8
S-6550	42,8	44,7	28,5	40,5	27,4	183,9	36,8	0,9	42,6
S-6545	42,4	29,2	27,8	31,1	34,5	165,0	33,0	0,4	34,5
UzFA-707	40,8	41,1	27,0	26,4	26,4	161,7	32,3	1,1	3,9
UzFA-710	41,4	46,7	28,0	22,4	35,8	174,3	34,9	1,2	21,8
\bar{X}_j	205,8	208,2	138,6	143,8	156,6	853,0	170,6		
\bar{x}_j	41,2	41,6	27,7	28,8	31,3	170,6	34,1		
Ij condition indices	7,0	7,5	-6,4	-5,3	-2,8				

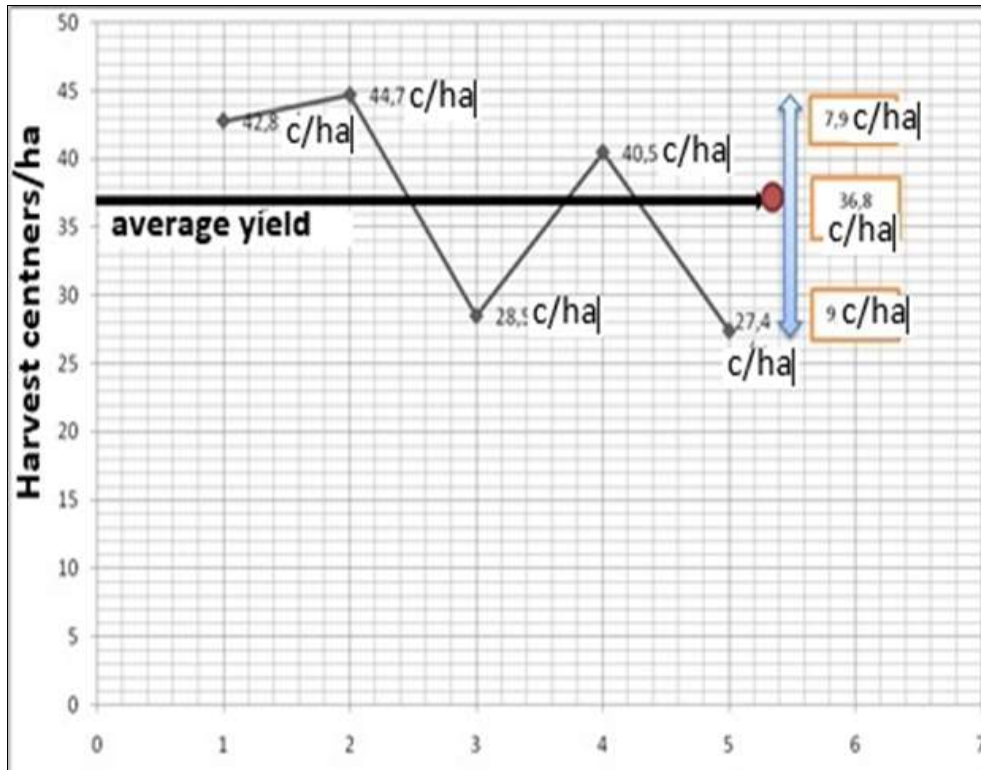


Fig 1: Average yield of cotton varieties C-6550

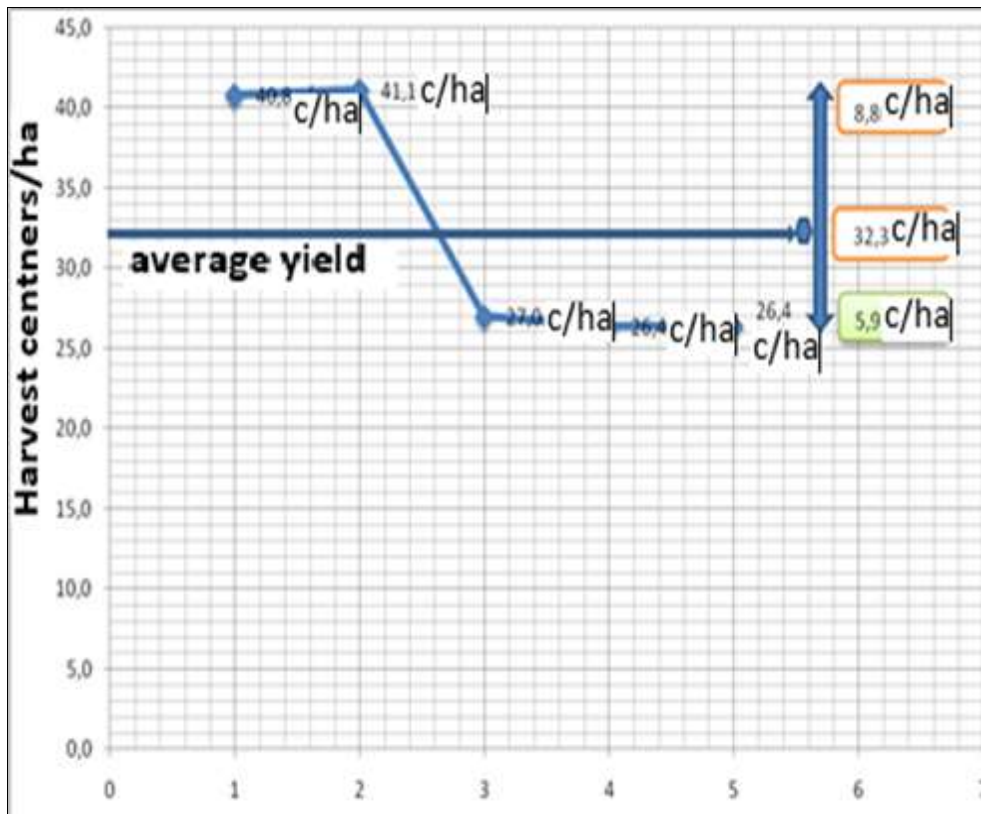


Fig 2: Average yield of cotton varieties UzFA-707

5. Conclusion

1. On the basis of the research carried out and the preliminary results obtained, the cotton varieties C-6550, C-6545, UzFA-707, YzFA-710 were distinguished by their yield compared to the standard variety “the Khamkor”.
2. The coefficients of regression, characterizing the response of varieties to changes in the level of yield,

turned out to be different. In the case when there is a complete correspondence of the yield of the variety to the change in test conditions, the regression coefficient is 1.00. The condition indices in this experiment varied from point to point by 0.5-4.7 centners / ha. Exactly the same variability is observed in cultivar C -6550, the regression coefficient of this cultivar is 0.9. The yield of “the Khamkor” cotton variety, despite significant

- fluctuations in the test points, on average changed by 1.3 ($b_i = 1.3$). The yield of the cotton variety UzFA-707 in the test points changed on average by 1.1 ($b_i = 1.1$).
3. It was revealed that the cotton variety C-6545 was more stable in comparison with other studied varieties. Although the yield of this cotton variety is neither maximum nor minimum, it gives a more stable yield.
 4. The coefficient of regression and variance of stability in combination with the analysis of average yields of varieties will make it possible to fully characterize their genotypic potential in terms of its ecological plasticity, homeostaticity and practical value. Thus, the assessment of varieties and hybrids for ecological plasticity is of interest both for theoretical research and for the introduction of varieties into production. This will reveal the possibility of supplementing the existing methodology of the State Commission, a new section on the study of the stability of cotton varieties in competitive trials.
 5. Carrying out such studies in ecologically different regions will allow the selection of new varieties of cotton that are more plastic and stable in terms of yield, which will create an opportunity to increase the yield in general due to the identified responsive and stable varieties.

6. References

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