საქართველოს მეცნიერებათა ეროვნული აკადემიის მოამბე, ტ. 4, №1, 2010
BULLETIN OF THE GEORGIAN NATIONAL ACADEMY OF SCIENCES, vol. 4, no. 1, 2010

Genetics and Selections

Forecasting of Economic Indices of New Mulberry Forms according to Correlative Selection and Correlative Characteristics

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ABSTRACT. **On the basis of analysis of experiments carried out at the Georgian Scientific Research Institute of Sericulture some regularities were determined between definite characteristics and economic indices of mulberry breeds, which enables us to choose the desired starting selection material at the initial stage of the study.**

The present paper deals with preliminary evaluation of nutritive values of mulberry leaf, productivity and resistance to diseases of new mulberry forms #158, #104 and #608 (leaf withering and nutritive value) according to diagnostic and correlative selective characteristics. *© 2010 Bull. Georg. Natl. Acad. Sci.*

Key words: *mulberry, correlative selection characteristics.*

Introduction. Selection of perennial crops is characterized by a series of peculiar characteristics, the principal one being manifold estimation of the economic indices of the selection material. Selection of mulberry plant is started in the grain department. The process of selection is continued in nursery and in plantations, for 3-5 years after its exploitation. After this the properties of the breed become stable and in conditions of ordinary care do not suffer changes. Evaluation of mulberry according to economic indices (productivity and resistance to disease, which is spread in this zone) is carried out against natural or specially created provocative background. Therefore choosing the starting material according to preliminary diagnostic or indirect correlative signs is very important for the matter of selection. This enables one to avoid heavy physical labor and material costs for their breeding.

As a result of analysis of results of long-term experiments carried out at the Georgian Scientific-Research Institute of Sericulture some regularities were determined between definite characteristics and economic indices of mulberry breeds. These are: relationship between intensity of sprouting and leaf productivity [1], between ratio of growing and not growing sprouts on a branch (1:1) and nutritive value of leaf, between leaf nutritive value and xerophyl anatomical structure, leaf assimilation/consumption and intercellular space of leaf mesophyl [2], between ratio of nutritive elements of leaf (proteins: carbohydrates 1:0.72) [3], between anatomical structure of sprouts and leaf petiole and resistance to leaf curl [4]. Alongside this, determination of breed peculiarities of new forms, together with morphological description, proceeds according to the form and quantity of cystoliths in leaf mesophyl [5] and according to spectral analysis of bud proteins. Proceeding from the foregoing the indices of growth and development, productivity, leaf nutritive value (physical properties, chemical composition) and resistance to disease - leaf curl - were studied on the basis of preliminary diagnostics and correlative selective characteristics. The breeds Oshima (resistant) and Gruzia (Georgia) (susceptible), radically differing from each other by their resistance to diseases, were used as controls.

Materials and Methods

New mutagenous forms #158 -obtained as a result of exposure of buds of Oshima breed mulberry tree to

radiation by Cs^{137} at 500 Gray, #608 - obtained as a result of exposure of buds of Tbilisuri, at 500 Gray, and #104 - obtained by exposure of wintered buds of Tbilisuri breed to radiation stimulated at 259 Gray, were studied.

The above-referred mulberry forms were selected first of all according to the growth of grafted saplings, degree of leaf falling and physical properties of leaf consistence. Observance over the character of growth and development of radio-mutant clones was performed in nursery for 2 years. Intensity of freezing of twigs in early spring, bud realization degree, quantity of sleeping buds on a sprout and other morphological characteristics and in autumn degree of maturing of branches were observed and registered. Chemical composition of leaf - anatomical structure of leaf and petiole, was studied by means of stereomicroscope DV-4.

The experiment was carried out in order to study the physical properties of leaves of the above-stated forms. The rate of leaf withering was determined by the method of weighing; leaf thickness, degree of letting down and leaf venation were determined according to organoleptic indices. Loss of mass was determined in every 2 hours for 24 hrs; final weighing was carried out after bringing the leaf to air-dry condition. The ratio of starting moisture and dry substances in the specimens, and then the losses of initial moisture were defined. Observations showed that loss of moisture in the breed Oshima and #608, in every 2 hours equaled 3%. In #104, the very index in the same period of time did not exceed 2%, in #158 – the rate of leaf withering was higher than in others, loss of moisture in every 2 hours totaled 5%.

It should be stated that the form #158 starts its vegetation earlier. Therefore its leaves enter the period of physiological maturity earlier, which in its turn affects significantly the physical properties of a leaf. This effect is expressed in the average veining of leaves.

The form #l04 as well as the form #158 is distinguished for intense leafing, great quantity of growing sprouts, leaf area and mass. Size of leaf plate and size of the whole assimilation surface is the index referring to the power of a tree crown. Power of a tree crown and amount of green mass were determined by counting leaves on 1 meter branch. Leaf mass was defined and relevant calculations were made.

The length of vegetation period in agro-ecological conditions equaled approximately 230 days. The shortest vegetation period is inherent to the form #608, then comes the form #104. The form #158 begins its vegetation early and ends late (232).

Intense rate of twig maturing is characteristic of the forms #158 and #608. In our opinion this is natural. Plants which are characterized by intense growth of branches (form #104), enter the phase of physiological repose late and the rate of branch maturing is relatively low.

As is seen from the results of the experiment, the total carbohydrate content in the form #158 is high by 5%, in other forms – below that of the control. The data of protein-carbohydrate ratio show that the ratio of these nutritive substances is higher in new forms compared to those of industrial breeds. It was proved that when the ratio is 1:0.72 – this is an optimal value [3]. This means that 0.72 weight share of raw protein comes per share of water soluble carbohydrate. At this ratio, both major nutritive elements of new forms of mulberry leaf are consumed by mulberry silkworm economically and according to the principal designation compared with those of breeds Oshima and Gruzia.

Ash element composition in prospective forms of mulberry tree is high compared with that of industrial breeds, being expressed in the coarsening of their leaves. As is known, the composition of ash elements in cell walls results in leaf coarsening.

The composition of ash elements in leaves of Oshima breed equals 9.31 %, in selection breeds this index varies within 11-12%.

In radio-mutant forms the content of sugars (glucose, saccharose) general nitrogen and raw protein is high too, which is a very important index for these forms. High is the content of protein substances, guaranteeing high nutritive value of leaves of these forms.

The quantity and variety of hydrolytic amino acids were determined in the above stated new mulberry forms. It was found that new mulberry forms are richer in nitrogen containing elements than Oshima and Gruzia. Hydrolysates of their leaves are rich in amino acids. Hydrolysate of leaves of the breed Oshima contains 11 types of amino acids, leaves of the form #104 contain 13 types of amino acids, #158 – 14 types and # 608 – 15 types.

Hydrolysates of leaves of all five specimens contain: norleucine, leucine, isoleucine, norvaline, methionine, alanine, tyrosine, glutamine and aminosuccinic acids, including irreplaceable leucine, isoleucine and methionine.

Alongside the above-listed amino acids one can find serine and lysine in the hydrolysate of leaves of Oshima breed. In #104 – valine, glycine, serine, lysine; In #158 – valine, glycine, arginine, lysine and cysteine; In #608 – phenyl alanine, valine, glycine, arginine, lysine and cysteine.

Hydrolysates of leaves of the forms #158 and #608 are rich in the number of amino acids. Likewise, high is the quantity of irreplaceable amino acids in these forms.

Table 1.

Chemical composition of leaves of prospective mulberry forms (in %)

Indices	Oshima Control	Gruzia (Georgia)	#158	#608	#104
Starting humidity	64.4	72.6	68.2	67.0	64.6
Dry matter	35.6	27.4	31.8	33.0	35.4
Water soluble carbohydrates					
In raw	3.34	3.75	3.81	-	3.03
In air-dry	10.20	10.7	10.7	-	9.50
In absolutely dry	11.4	12.2	12.0	-	10.7
Protein-carbohydrate ratio	1:0.94	1:1.20	1:0.82	-	1:0.83
Ash					
In raw	2.46	3.08	3.79	3.54	3.55
In air-dry	8.52	9.70	11.73	10.69	11.16
In absolutely dry	9.31	10.53	12.85	11.45	12.19
Mono-saccharides					
In raw	0.33	0.79	0.42	0.41	0.29
In air-dry	1.16	2.5	1.3	1.24	0.90
In absolutely dry	1.27	2.72	0.98	1.43	1.33
Amino acid type	11	12	14	15	13
General nitrogen					
In raw	0.56	0.59	0.74	-	0.58
In air-dry	1.72	1.70	2.08	-	1.82
In absolutely dry	1.92	1.91	2.32	-	2.04
Raw protein					
In raw	3.52	3.67	4.64	-	3.63
In air-dry	10.75	10.62	13.00	-	11.37
In absolutely dry	12.01	11.92	14.56	-	12.77

Note: Table 1 presents average values of 2 years.

Thus, e.g. there are 5 irreplaceable amino acids (valine, leucine, isoleucine, methionine, lysine) in the form #158.

There are 6 irreplaceable amino acids (leucine, isoleucine, phenyl alanine, valine, methionine, lysine) in the form #608.

Anatomical structure of leaf petiole of referred to forms were studied with the view of those correlative characteristics which to a certain extent condition leaf nutritive value and resistance to diseases [5]. Namely, amount of soft bast, bast thickness, thickness of collenchyma in perimedullary zone, quantity of vesicular and radial rays were determined. The results are given in Table 2.

In the selection of mulberry tree with a view to immunity, advantage is given to forms with fine cellular anatomical structure, with excess of physiologically active elements, with great quantity of soft bast. The investigated forms attract great attention with a view to selection, compared with the tolerant breed Oshima. In the form #158 quantity of soft bast in peripetiole equals to 29.2, in mesopetiole – 18.7, in the form #104 – to 26.8 and 12.1 instead of 22.3 and 12.7 in the breed Oshima. According to the bast thickness and quantity of vessels in #158 exceeds that in the control breed, and form #104 is characterized by relatively large vesicular anatomical structure compared with that of the form #158 and control.

Measuring the elements of anatomical structure of new mulberry selection forms and chemical composition of leaf enables us to assert that leaves of the form #158 are more nutritive, assimilation depends on the size of intercellular space and rate of veining of leaves and that any nutritive value of new mulberry forms is conditioned by anatomical structure; excess of vascular-fiber nodes ensures immediate link between leaves and roots. It refers to more intense process of metabolic and assimila-

Table 2.

Measuring anatomical structure of leaf petiole of new mulberry breeds

##	Breed, mc	Collenchyma thickness, mc	Bast thickness, mc	Perimed. zone thickness	Amount of soft bast		Number of vessels pcs	Number of rad. rays, pcs
					In peri-petiole	In meso-petiole		
1	Oshima (control)	297.0	104.5	125.4	22.3	12.7	392.0	55.3
2	#158	225.2	110.0	89.8	29.2	18.7	423.2	39.8
3	#104	273.5	100.9	90.8	26.8	12.1	370.1	42.6

tion processes. This is well proved by a large quantity of growing sprouts of the form #104.

Conclusion

1. Physical properties, chemical composition and peculiarities of anatomical structure of new mulberry forms #158 and #608, compared with the tolerant breed Oshima enable us to use these forms in selection of leaf quality and immunity and the form #104 – can be used in selection of productivity.

2. The above-listed radio-mutant mulberry tree forms are tested at the level of the Institute as new breed-candidates.

გენეტიკა-სელექცია

თუთის სამეურნეო მაჩვენებელთა პროგნოზირება სასელექციო კორელაციური ნიშნებით

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მეაბრეშუმეობის სამეცნიერო-კვლევით ინსტიტუტში შესწავლილ იქნა თუთის ახალი ფორმები ისეთი სასელექციო ნიშნებით, რომლებიც დადებით კორელაციურ კავშირში არიან მათ სამეურნეო მაჩვენებლებთან, როგორიცაა: ტოტზე მზარდი და არამზარდი ყლორტების თანაფარდობასა (1:1) და ფოთლის კვებით ღირებულებას შორის, ფოთლის ქსერომორფულ ანატომიურ აგებულებასა და ყუათიანობას შორის,ფოთოლში ცილა-ნახშირწყლების თანაფარდობასა (1:0.72) და მის ყუათიანობას შორის, ფოთლის ყუნწში ლაფნის ბოჭკოების რაოდენობასა (>10) და დაავადებებისადმი მდგრადობას შორის, ფოთლის მეზოფილის უჯრედშორისი სივრცის სიდიდესა და აბრეშუმის ჭიისათვის მის შეჭმადობას შორის და სხვ.

აღნიშნული კორელაციური კავშირებით გამორჩეული იქნა თუთის პერსპექტიული ფორმები #158, #104, #608 როგორც მაღალმოსავლიანი, დაავადებებისადმი მდგრადი და მაღალი კვებითი ღირებულების მქონე ახალი ჯიშთკანდიდატები.

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Received July, 2009