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APPLICATION OF MODERN METHODS IN VIRGINIA SPECIES TOBACCO PRIMARY PRODUCTION AND PROCESSING

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Abstract: The purpose of these tests is an attempt to contribute to new technology of plantlet (Todd's Cells) in mass production for developing economical, safer and quality tobacco production. The study includes two ways of plantlet production and three varieties of Virginia Species Tobacco. The results of parallel testing of tobacco production obtained from plantlets of different origins have shown that the new way of breeding has many advantages. Todd's Cells plantlet was ready for transplantation earlier and it reached the technological maturity in the open field earlier than usual. The time necessary for leaves drying was shorter in 12 hours and so the later processings (redrying, cigarettes production) were done in a shorter time. The plants in the field were more resistant to disease agents because Todd's Cells plantlets had easier adjusted to the environmental conditions. Tobacco leaf yield from Todd's Cells was significantly higher than from the traditionally produced plantlet. Raw material quality was also better. At the end, it is important to line out that the different plantlet production methods of different varieties reacted differently to yield and raw tobacco material quality.

Key words: plantlet production, traditional method, Todd's Cells, varieties, leaf yield, quality of raw tobacco material.

Introduction

Plant of tobacco made a significant influence on political, economical, social, and religious life of all people who traded with it, produced, processed and used it.

Two basic ecotypes dominate the production, the oriental (Eastern) and the occidental (Western). By the end of the eighties oriental tobaccos were mainly

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bred on our lands, their main characteristics are that they are small-leaved and aromatic. Changing the method of technological cigarettes production, occidental tobaccos became more interesting. Main occidental tobaccos characteristics are that they are big-leaved with less aroma and bigger leaf yield. Varieties of these tobaccos are not suitable for traditional plantlet production in hot and semi-hot beds. The most important occidental cigarette tobaccos are *Virginia*, *Barley* and *Maryland*.

In our country, occidental tobacco plantlet production in Todd's Cells started in 2000 and the first results have shown that it is justifiable, though the investments in these projects are much bigger than in the ordinary beds. The new method of tobacco plantlet production was named after its creator George Todd who (in 1982 in Ontario) developed the seeding system in polystyrene cells which are connected into containers. Before seeding he filled the cells with nutritive sterilized mixture, so he didn't have to use methyl bromide. After the seeding he placed the containers into a pool filled with water and plant assimilates (Culture of Tobacco Seedlings Todd's Cells. Factsheet, 1982, Ontario).

Future improvement came with submerging the Todd's Cells frames in pools with water. Seeds with nutritive substrates are placed into carrier cells made of polystyrene which floats on the water in the pool. In that way young plants are bred in hydroponics (Float Greenhouse Tobacco, David Reed, Transplant Production Guide, publication number 436-051, January 1998); G, Carrasco, P, Rebolledo and P. Valverda took part in further improvement of Todd's Cells system. They published the results of their research in Producing Tobacco Transplants journal in Chile 1988. L. A. Sallies, D. A. Sosa and A. Valeira-Global point out in their research made in Argentina that it is possible to produce plantlets of other plants whose vegetation period in the open field needs to be shortened. Also, it is possible to replace the traditional method of plantlet protection treatment with alternative systems (Alternatives for the replacement of methyl bromide in Argentina, p. 1-15, FAO, 1989.). Since 2003, in our country in the area of tobacco production and processing companies Senta and Čoka, the experimental tobacco plantlet production, started in this way and the first experiences were very encouraging (N, Djokić), but there are still no scientific results.

Material and Methods

NC-55 represents a new generated variety which has high adjustment ability to different breeding conditions. This variety has a semi-dwarf and firm haulm on which there are up to 20 leaves. Genetically, it is resistant to viruses, while the root system is resistant to nematodes.

Heveši-9 can be bred in light sandy and semi-fertile soil, so it has less need for nitrogen. Leaves have good yellowing characteristic during the drying process.

Semi-hot beds. Tobacco hand sowing was done on March 20 in the pre prepared semi-hot beds (20m x 4m). Bed preparation includes treatment of mixture of manure, sand and fertile soil, also it includes methyl bromide disinfection and polyethylene foil coverage. After plant emergence on April 5, standard measures of plantlet nursering and protection were performed. Crop protection against weeds was carried out manually, against insects spraying with insecticide Confidor and against pathogen fungus with Ridomil fungicide. Tobacco plantlets were two times nutritioned with KAN; they were regularly watered and aerated. Just before taking it to the open field, the plantlet was gradually adapted to the environmental conditions. Tobacco machine transplantation on the open field took place on May 10. The plantlet was of average height of 10 cm (5-leaf phase).

Todd's Cells. Tobacco plantlet was produced in water filled pool (200m ^{2} of surface; 30 m x 6.92 m) with dissolved nutritive up to the height of 10cm. Over the nutritive solution, container cells floated, where treated tobacco seeds were planted in special sterilized nutritive substratum Fruhstofer Erde (Table 1).

T a b.1. - Qualities of container filling substratum

Substratum Features	50% moss (pine-saw dust etc...)
	50% vermiculite or perlite
	pH 5.8 – 6.3 (slightly acid reaction)
	Small content of nutrient
	Substratum humidity (water content up to 60%)
	pH 5.8 – 6.3 (slightly acid reaction)
	Good water absorption and its capillary diffusion to the seed

On March 28 the hand sowing and placing of containers on nutritive medium was, carried out and on April 10 the plants emergence occurred. During the plants development the following agrotehnical measures were applied in the plantlet: addition of nutritive, substratum and solution correction with additives, maintaining of the constant facilities warmth, plantlet ventilation, tobacco protection from diseases' agents and pests by using the Ridomil and Confidor pesticide, algae control and algae extermination in the pools, plantlet trimming (three mowings) and plants hardening before taking them to the open field. Transplantation took place on May 10 with row distance of 70 cm x 50 cm.

Two-factorial macro test was carried out by the split-plot system with four repetitions, so that one half was planted with traditionally produced plantlet and the other half was planted with Todd's Cells plantlet.

During the plants' development in the open field, the crop was cultivated and weeded three times. With the appearance of the first flowers deumbeling was carried out manually and the tillers were removed with a chemical physiothrop Royal MH-30. For weed suppression, herbicide Focus-ultra was used. Against the pathogenic fungus Peronospora tabacina Adam, blue mold disease agent,

preparation Sandofan was used. Soil pests were suppressed by granulated soil insecticide treatments, trips preparation Confidor WG-70. On July 25 manual harvest of middle insorption leaves (10-12 leaves) was carried out.

Primary leaves processing started in Tabex T-78 dryer. Drying dynamics undergoes the following stages: yellowing, color fixation, leaf and primary nerve drying (Table 2).

T a b. 2. - Parallel preview of tobacco leaves drying process

Traditional method		Todd's Cells	
Temp. Relative Humidity	Drying dynamics	Temp. Relative Humidity	Drying dynamics
32°C 90%	The start of leaves yellowing (tanning)– 16 hours	32°C 90%	The start of leaves yellowing (tanning) – 15 hours
39°C 82%	Half of tanning process– 15 hours	39°C 80%	Half of tanning process – 13 hours
39°C 79%	End of yellowing – 11 hours	39°C 78%	End of yellowing– 11 hours
39°C 75%	Termination of primary nerve drying – 8 hours	39°C 73%	Termination of primary nerve drying – 7 Hours
43°C 63%	Beginning of leaves rolling– 19 hours	43°C 63%	Beginning of leaves rolling – 19 hours
52°C 45%	Termination of leaf blade rolling and color fixation – 15 hours	52°C 44%	Termination of leaf blade rolling – 14 hours
60°C 34%	Termination of the complete leaf blade drying – 15 hours	60°C 33%	Termination of the complete leaf blade drying – 12 hours
70°C 20%	Termination of primary nerve drying – 10 hours	70°C 19%	Termination of primary nerve drying – 10 hours
40°C	Leaves cooling – 2 hours	40°C	Leaves cooling – 2 hours
40°C	Leaves wetting – 8 hours	40°C	Leaves wetting – 8 hours
Total	119 hours	Total	107 hours

These data show certain variation in the timing of leaves drying process, depending on the method of tobacco production. Tobacco leaf drying process of the traditional plantlet lasted 119 hours in total, and the same process of the Todd's Cells plantlet lasted 107 hours in total, that is, 12 hours less. In that way, about 8% of natural gas was saved. Todd's Cells tobacco reached technological maturity earlier and had less water in its leaves. Termic leaves processing with a redrying method was performed by standard method which includes: drying at 116°C in the first zone, then cooling at 35°C and the third wetting zone on the total leaves wetting of 11.5 - 12%. With this action, primary tobacco processing is finished.

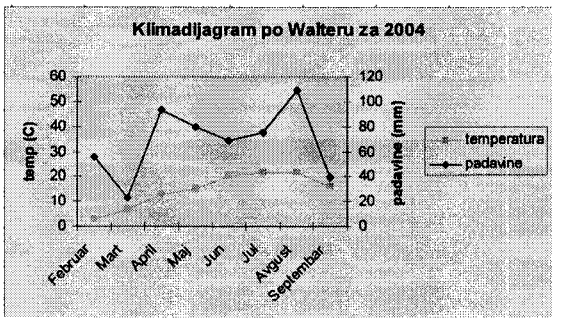
Laboratory test of tobacco quality control also includes organoleptic quality evaluation, physical and tasting parameters, while the chemical structure was done at The Tobacco Institute in Prilep.

The obtained results were processed by modern biometrical methods for the two factorial tests; the analysis of the certain treatments was done with the LSD test, with the certainty of 95% and 99%.

Meteorological conditions

In the year during which the tests were carried out, meteorological conditions in the area of the north-eastern Srem (Maradik) were very satisfactory for open field plant development (climadiagram 1).

Climadiagram1



Climadiagram by Walter for 2004
precipitations
temperature
(February, March, April, June, July, August, September)

Meteorological conditions data were obtained from the nearest Meteorological station in Sremska Mitrovica

Results and Discussion

Influence of plantlet production method on yield index

T a b. 3. - Leaf yield per plant, yield in total and dry leaves share

Traditional plantlet breeding method			
Characteristic	NC-55	PVH-19	Heveši-9
Raw leaves yield	78	67	89
Dry leaves yield, g	5.85	5.09	7.20
Yield in total, kg/ha	1,720	1,683	2,140
Todd's Cells			
Characteristics	NC-55	PVH-19	Heveši-9
Raw leaves yield, g	94	86	94
Dry leaves yield, g	7.24	6.45	8.08
Yield in total, kg/ha	2,115	1,908	2,510

(Raw leaves yield) LSD 5% = 26.5 1% = 35.8

(Dry leaves yield) LSD 5% = 2.19 1% = 2.94

(Leaves yield in total) LSD 5% = 431 1% = 578

NC-55 variety had better producing qualities, while for this producing area Heveši-9 variety produced better results. With this variety, significantly higher raw and dry leaves yield was obtained. Plantlet production method had also shown significant variations in crop index. The tobacco obtained from the Todd's Cells plantlet had better producing qualities, in terms of raw leaves as well as in terms of dry leaves. The interaction between the varieties and the plantlet production method was not statistically significant.

Influence of plantlet production method on organoleptic tobacco leaves quality

T a b. 4. - Organoleptic tobacco leaves qualities

Variety NC-55		
Parameters	Traditional method	*Todd's Cells*
Leaf size and shape	Big leaf, elliptical	Big leaf, elliptical
Leaf nervature	Expressed	Less expressed
Leaf thickness	Thin	Thin
Tobacco aroma	Slightly aromatic	Slightly aromatic
Leaf coloration	Light yellow, thin, no shine	Light yellow, thin no shine
Complex tissue qualities	Soft, thin, semi elastic	Soft, thin semi elastic
Tissue content	Full	Full
Tobacco leaf defects and damaging	Light greenness with secondary nervature	None
PVH-19 variety		
Leaf size and shape	Not big, fish shaped	Less big, fish shaped
Leaf nervature	Very expressed	Expressed
Leaf thickness	Thin	Thin
Tobacco aroma	Not expressed	Slightly expressed
Leaf coloration	Light yellow with dark spots, presence of greenness	Light yellow, scattered spots
Complex tissue qualities	Semi elastic	Less flexible on the bend
Tissue content	Less full	Less content
Tobacco leaf defects and damaging	With spots	Less spots
Heveši-9 variety		
Leaf size and shape	Very big, oval	Very big, oval
Leaf nervatue	Primary nerve is expressed and the secondary are thin and very fine	Primary nerve us expressed and secondary nerves are thin and very fine
Leaf thickness	mid thin	mid thin
Tobacco aroma	Less aroma , typical	Aromatic, typical
Leaf coloration	Light yellow, shiny	Light yellow, extremely shiny
Complex tissue qualities	Very elastic	Very elastic and fine
Tissue content	Very full	Very full
Tobacco leaf defects and damages	none	None

Organoleptic tobacco leaves assessment of the varieties tested had shown that the best qualities were found in Heveši-9 variety obtained from Todd's Cells plantlet production method. It should be pointed out that very good leaves qualities of this variety were obtained when plantlet was produced by traditional method. The second place, considering the organoleptic qualities has NC-55 variety, with the leaves of the Todd's Cells plantlet production method. The smallest organoleptic tobacco qualities gave PVH-19 variety, and more with the leaves plantlet produced by traditional method.

Influence of plantlet production method on physical qualities of tobacco leaves

T a b. 5. - Physical qualities of tobacco leaves

Variety	NC-55		PVH-19		Heveši-9	
Method	Tradition.	*Todd's*	Tradition.	*Todd's*	Tradition.	*Todd's*
Qualities						
Leaf length, cm	50.7	51.4	45.4	45.6	54.0	55.3
Leaf width cm	20.5	21.3	22.4	22.1	26.1	27.2
Length and width relation	2.47	2.41	2.02	2.06	2.06	2.03
Leaf blade thickness mm	0.08	0.08	0.07	0.07	0.08	0.08
Leaf mass, g	95.58	99.30	84.50	87.30	138.25	140.65
Leaf nerves mass, g	26.32	24.85	21.54	22.90	31.95	30.87
Primary nerve share, %	27.50	26.50	25.5	27.20	23.1	22.40
Volume mass, g	0.8988	0.8960	0.8929	0.8980	0.8370	0.8229
Gram volume	1.1125	1.1160	1.1199	1.1130	1.1947	1.2152
Waterproof capacity	24.90	25.20	25.10	25.30	27.30	27.85

Average leaf dimensions were 45.5 cm x 22.3 cm. Analysis of value of leaf-size shows that during the study year, PVH-19 had the smallest leaves. NC-55 had leaves longer by 12% but narrower by 6%. Heveši-9 had the largest leaves; the leaf blade was longer than standard by 20%. On the other side, there were no significant variations considering the plantlet breeding. When compared to the average physical parameter values for Virginia type tobaccos, approximately closest, considering its characteristics, is NC-55. Heveši-9 variety had the best physical parameter results, especially with the tobacco plantlet produced in Todd's Cells. Lastly, meteorological and soil conditions affected the genetic yielding of the researched varieties.

Influence of plantlet production on the tobacco leaves chemical structure

The way of tobacco breeding, as well as the varieties included in this research has shown significant variations considering the tobacco chemical structure (Table 6).

Analysis of chemical qualities of tobacco leaves has shown that Heveši-9 variety had best quality and that from the plantlet production in Todd's Cells. The quantity of nicotine, as the most important parameter for tobacco leaf quality

assessment, varied depending on the variety and the plantlet production method. Analyzing single treatments, it was noted that PVH-19 variety leaves from traditional plantlet production had 2.1% of nicotine, while the NC-55 variety leaves had the smallest quantity. And so considering this variety, whose leaves come from Todd's Cells plantlet production vary in 1.8%. Other variations were insignificant. Due to the present knowledge, average nicotine in Virginia type tobacco leaves, bred in the ecological conditions in Vojvodina, vary from 1.6% to 2.20%. These results show that varieties NC-55 and PVH-19, which were bred in the production area for the first time, represent a good genetic material. It should be pointed out that the already domesticated variety Heveši-9 has a better leaves quality because it contained less nicotine quantity.

Tab.6. - Average chemical leaves structure, %

Traditional method of plantlet breeding			
Qualities	NC-55	PVH-19	Heveši-9
Mineral matter	14.75	19.39	15.45
Nitrogen in total	2.07	2.73	2.10
N-proteins	0.56	0.98	0.77
Proteins	5.53	7.20	6.59
Nicotine	1.93	2.10	1.87
Reducing substance in total	25.03	20.05	26.70
Polyphonies	2.85	2.45	3.24
Soluble sugars	22.18	17.05	23.54
PH	5.32	5.48	5.30
Todd's Cells			
Qualities	NC-55	PVH-19	Heveši-9
Mineral matter	14.70	19.20	15.90
Nitrogen in total	2.11	2.80	2.06
N-proteins	1.03	1.90	0.70
Proteins	5.40	6.77	6.40
Nicotine	1.80	1.93	1.86
Reducing substance in total	25.00	19.80	27.10
Polyphonies	2.80	2.30	3.19
Soluble sugars	22.20	17.58	25.98
PH	5.30	5.39	5.28

PVH-19 variety had the smallest quantity of soluble sugar (17.31%). This sugar quantity was smaller than in the average values of Virginia type tobacco. Such a small quantity of soluble sugars was smaller (by about 28%) than in the two other varieties (NC-55 and Hevesi-9). In our research, compared with the best variety Heveši-9, the quantity of soluble sugars was smaller by approximately 43%. In total average, more of the soluble sugars were found in the tobacco leaves when the plantlet was produced in Todd's Cells.

Quantities of mineral matter, as a parameter significant for tobacco quality, were within the limits of 11.50 to 17.30%. Values given by the sample analysis

show that the quantities of mineral matter were in optimal quantities for this tobacco type. PVH-19 variety is an exception because of the growth of mineral matter content in about 20% compared to other two varieties

From the aspect of tobacco quality, no chemical parameters can be observed singularly, only combined with other parameters. Between certain chemical matter relations there are some cause-effect relations which define the quality and they are manifested through the organoleptic and tasting tobacco qualities

Considering the influence of plantlet production method, in all three varieties, it is noticed that the Todd's Cells plantlet gave better quality plants

Influence of plantlet production on tasting qualities of cigarettes

Plantlet breeding method, as well as the varieties included in this research, has shown a certain influence on tasting tobacco qualities. (Table 7).

T a b. 7. - Tasting qualities of cigarettes made of tobacco leaves

Qualities	NC-55		PVH-19		Heveši-9	
	Traditional	*Todd's*	Traditional	Todd's	Traditional	*Todd's*
Physiological resistance	9 light	9 light	8 light	9 light	3 strong	4 medium strong
Taste keenness	7 less severe	7 less severe	7 less severe	8 mild	4 less severe	4 less severe
Taste quality	7 satisfies	8 good	6 satisfies	6 satisfies	8 good	8 good
Aroma intensity	5 medium aromatic	7 medium aromatic	6 medium aromatic	6 medium aromatic	6 medium aromatic	7 medium aromatic
Aroma fineness	5 medium fine	6 medium fine	6 medium fine	7 medium fine	6 medium fine	7 medium fine
Smoking fullness	6 medium full	7 medium full	7 medium full	7 medium full	7 medium full	8 full
combustibility	6 satisfies	7 satisfies	7 satisfies	8 good	9 good	8 good

Tasting cigarettes made of tobacco leaves of these varieties showed the following:

- NC-55 variety tobacco leaves produced by traditional method left an impression of a mild cigarette, with a mild mucous membrane teasing and a taste of grounds in your mouth. Cigarette aroma is not enough expressed, smoking fullness is not specially expressed; it has satisfactory combusting ability during which a grey non compact ashes is produced.

- Cigarettes made of PVH-19 variety leaves, when smoking, left an impression of a mild cigarette, they coat the tongue in small quantities, aroma is

mild-intensive, but pleasant. Smoking fullness is not expressed, the flavor is harmonic and the combustibility is satisfactory. Ashes are light grey with slight scaly.

- Heveši-9 variety, during smoking, has an extremely defined strong taste, which produces a nasal membrane teasing. Aroma is mild intensive, harmonic and pleasant. Combustibility is equal and good. Ashes are light grey and compact.
- NC-55 variety tobacco leaves during smoking manifested a mild taste with a light teasing of the other half of the tongue. Aroma is slightly expressed, no expressed smoking fullness. Combustibility is satisfactory, ashes are light grey and compact
- Cigarettes made of PVH-19 tobacco leaves variety, during smoking, produce mild taste. This cigarette leaves a significant quantity of grounds in mouth. Aroma is not intensive, but it is harmonic. Smoking fullness is not specially expressed. Combustibility is satisfactory during which light grey incompact ashes are produced.
- Heveši-9 variety is a raw material which "produces" a cigarette with a distinct physiological strength with a mild tongue membrane teasing. Smoking fullness is expressed with a stable and pleasant mild aroma. Combustibility is good; ashes are compact and light grey.

Conclusion

From research results for the influence of the plantlet production method and the varieties on the yield and quality of tobacco leaves, the following can be concluded:

Comparing the traditional plantlet production method with the new technological method (Todd's Cells), we concluded that the tobacco was ready for transplantation 11 days earlier;

Also, the tobacco in the open field reached the technological maturity earlier. Besides the early maturing, the leaf yield per plant was higher by about 17% with the new plantlet production. Statistically, this is very significant enlargement, so this way of plantlet production can be recommended;

Plantlet production method influenced significant by variations of the whole yield of the mid-insertion leaves. Statistically, a higher raw leaf yield was in the variety NC-55 when it was produced by Todd's Cells than by the traditional method;

Dry leaf yield was also higher in the Todd's Cells plants. Yield growth for all varieties was about 17%, but this difference is not significant in group treatments Considering that the tobacco leaves from the Todd's Cells plants had less water, drying period lasted 107 hours or by 11% shorter than drying period of traditional plantlet production. This difference caused an 8% of fuel saving of total natural gas quantity needed;

With organoleptic leaves estimate, it can be concluded that Heveši-9 variety had less qualities for both plantlet production methods tested;
Analysis of average values of the Virginia species tobacco physical quality, bred in this area up till now, compared with the results given, showed that variety Heveši-9 was on the whole much above the standard;

Based on the tobacco chemical leaves structure, this research showed that plantlet production in Todd's Cells is completely justifiable. This specially stands for Heveši-9 variety which in singular analysis was the best;

Better tasting analysis had cigarettes made of tobacco leaves of the Todd's Cells plantlet production.

Applying the new technology in tobacco production gives a bigger crops control in a controlled environment, which enables the production of a high quality plantlet. Such a plantlet revives faster in the open field, plants are more resistant to drought, disease agents and they are ready for harvest earlier.

Bigger investments which are necessary for building plastic green-houses and gathering the accessories will be justifiable with obtaining better quality plantlet with less production expenses. This cost lowering is visible in more simplified measures of crop care and protection, with certainly higher leaf yield per surface unit, shorter drying time, better quality retrying processing and obtaining more quality raw material.

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PRIMENA SAVREMENIH METODA U PRIMARNOJ PROIZVODNJI I OBRADI DUVANA TIPA VIRDŽINIJA

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R e z i m e

Cilj ovih istraživanja je pokušaj da se nova tehnologija gajenja rasada (*Todove ćelije*) uvede u masovnu proizvodnju radi ostvarivanja ekonomične, sigurne i kvalitetne proizvodnje duvana. Proučavanja su obuhvatila dva načina proizvodnje rasada i tri sorte duvana tipa virdžinija. Rezultati uporednih istraživanja proizvodnje duvana dobijenog iz rasada različitog porekla pokazali su da novi postupak gajenja u zaštićenom prostoru ima niz prednosti. Rasad iz *Todovih ćelija* ranije je stasao za presađivanje tako da je i u polju pre dostigao tehnološku zrelost. Sušenje listova bilo je kraće za 12 časova pa su i kasniji postupci prerade (ridraing, proizvodnja cigareta) izvedeni za kraće vreme. Biljke su u polju bile otpornije na uzročnike bolesti jer se rasad iz *Todovih ćelija* lakše prilagodio uslovima spoljne sredine. Prinos listova duvana bio je signifikantno veći iz rasada *Todovih ćelija* nego iz tradicionalno proizvedenog rasada. Kvalitet sirovine bio je, takođe, veći. Na kraju, treba istaći da su i sorte različito reagovale prinosom i kvalitetom duvanske sirovine na načine proizvodnje rasada.

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